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SUMMARY OF VEGETATION CHANGES ON DREDGED MATERIAL AND ENVIRONMENTAL MANAGEMENT PROGRAM SITES IN THE ST. PAUL DISTRICT, CORPS OF ENGINEERS

by

Robert Anfang, St. Paul District, Corps of Engineers
and
Gary Wege, Twin Cities Field Office, U. S. Fish and Wildlife Service

November 2000

Horseshoe Island, Pool 8, Phase I. August 1992.

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TABLE OF CONTENTS

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14. ABSTRACT

This report summaries the results of vegetation monitoring activities on dredged material placement sites on the Upper Mississippi River between Minneapolis, Minnesota and Prairie du Chien, Wisconsin. The objectives for establishing vegetation were to reduce erosion, provide cover for wildlife and aesthetics. Information on each site includes site description and vegetation treatments, summary tables for percent cover, frequency, dominance, and important value information, Robel pole readings, and photographs. Also included is a list of common and scientific names of plant species. The study found that the vegetation monitoring sites were successful in obtaining the objectives. A notable conclusion from the study was that fine material increased the density of both planted and naturally occurring vegetation.

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TABLE OF CONTENTS (cont)

List of Figures

List of Tables

TABLE OF CONTENTS (cont)

TABLE OF CONTENTS (cont)

APPENDIX

SUMMARY OF VEGETATION CHANGES ON DREDGED MATERIAL AND ENVIRONMENTAL MANAGEMENT PROGRAM SITES IN THE ST. PAUL DISTRICT, CORPS OF ENGINEERS

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INTRODUCTION

This report summarizes the results of vegetation monitoring activities on dredged material placement sites and Environmental Management Program Habitat Rehabilitation and Enhancement Projects (HREP's) constructed in the St. Paul District by the Corps of Engineers in cooperation with other Federal and State agencies (U.S. Fish and Wildlife Service and Minnesota, Wisconsin and Iowa Departments of Natural Resources). The planting work and monitoring activities started in 1982 on dredged material placement sites, and expanded in 1988 to include HREP projects. This report does not include projects undertaken by the Natural Resources Section of the St. Paul District for Project Operations Activities. Most of these projects involve the planting of trees and other forest management treatments. Common and scientific names of plants used in this report are found in the Appendix.

Within the St. Paul District, the 9-Foot Channel Project is an existing operational project consisting of 13 locks and dams, supplemented by maintenance dredging, that facilitates commercial barge navigation on the upper reaches of the Upper Mississippi River system. The St. Paul District maintains a 9-foot navigation channel in the Upper Mississippi River from the head of navigation at Minneapolis, Minnesota (river mile 857.6), to just below Lock and Dam 10 at Guttenberg, Iowa (river mile 614.0), for a total distance of 243.6 river miles.

Dredged material generated from maintaining the 9-foot navigation channel consists mainly of coarse- to medium-grained sand, which is usually placed hydraulically in confined placement sites in the floodplain. The sand dredged material is very low in fertility and slow to revegetate naturally. It is common to see bare sand with only scattered plant growth 20 years or more after the initial placement.

Vegetation studies monitored in this report (see Figure 1) have taken place along the Upper Mississippi River (UMR) between Minneapolis, Minnesota, and Prairie du Chien, Wisconsin (Pools 1 through 10). Common objectives at planting sites are to control erosion, provide wildlife habitat, and improve the aesthetic appearance. In general, establishing native prairie habitat conditions at these sites is the desired outcome.

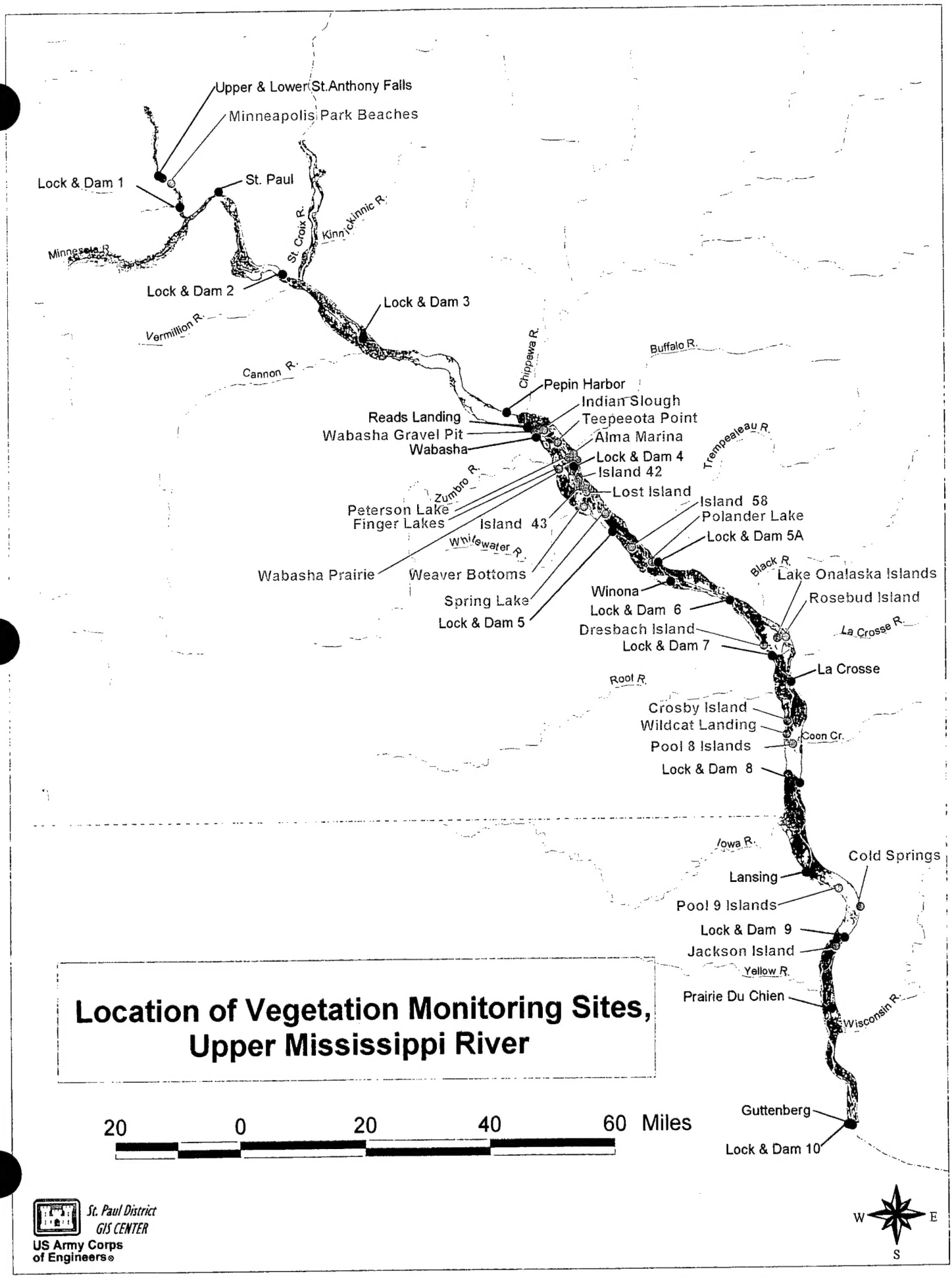


Figure 1. Location of vegetation monitoring sites, Upper Mississippi River.

In the early years, the primary method used to achieve these objectives was planting of bare sand by seeding a variety of warm- and cool-season grasses (i.e., switchgrass, side oats grama, little bluestem, big bluestem, Canada wild rye, and Indian grass). Application of fertilizer was tested to try to increase available nutrients. Native species that tolerated sand conditions on the Upper Mississippi River were planted on sand dredged material sites (i.e., sand dropseed), as were non-native species (i.e., American beachgrass). In general, planting of bare sand by seeding grasses was an improvement over natural processes, but it took a long time for plants to become established and it did not provide suitable wildlife habitat conditions in comparison to the desired outcome of establishing native prairie. Beach grass became well established on sandy sites but provided a monotypic stand; it also took several years for establishment to occur since the plants reproduced by rhizomes. So, other vegetation measures were tested.

Sometimes, maintenance dredging occurred in lock chambers or their approaches and involved fine sediments containing silt and clay. This material was dredged mechanically and placed in barges. To test the benefits of using it as topsoil, these fine sediments were transported to historic sand placement sites. Here, the material was spread over the sand and left to revegetate naturally (species composition depended on the seed bank contained in the sediment), or was seeded with desirable species. Spraying fine sediment dredged from backwaters onto sand deposits using irrigation equipment was also tried. Placing fine sediment on sand proved to be a valuable technique for future vegetation efforts on the Upper Mississippi River.

In the 1970s, the Great River Environmental Action Team (GREAT) study provided a variety of recommendations to rehabilitate Weaver Bottoms, a large backwater area in Pool 5. The Lower Pool 5 Channel Maintenance/Weaver Bottoms Rehabilitation Project was constructed by the St. Paul District in 1986. It was the first major Operation and Maintenance (O&M) project on the Upper Mississippi River to incorporate both channel maintenance and habitat rehabilitation objectives. A major portion of the project consisted of six side-channel closing structures along the main navigation channel and a side channel, and two large islands in Weaver Bottoms. A planting program was implemented for project features and included a variety of species and treatments. At some treatment sites, fine sediment was dredged from adjacent open-water areas (i.e., backwaters); this was the first project where fine sediment was hydraulically placed on sand within containment levees, incorporated with the sand to form a soil, and routine farming equipment used to prepare the soil and conduct the seeding. The Weaver Bottoms project provided a wealth of information for planning future habitat enhancement projects on the Upper Mississippi River and vegetation activities. The results of this project are summarized in Nelson, et al., 1998, "The Weaver Bottoms Rehabilitation Project, Resource Analysis Program." U.S. Fish and Wildlife Service, 51 East 4th Street, Room 101, Winona, Minnesota, 172 pp.

The Environmental Management Program for the Upper Mississippi River System (EMP-UMRS) was authorized by Congress in the Water Resources Development Act of 1986. A major element of the EMP is construction of Habitat Rehabilitation and Enhancement Projects (HREP's) involving habitat protection, restoration, and monitoring of their ecological effectiveness. Habitat protection and restoration measures include dredging to deepen aquatic habitat, construction of islands, hydrologic modifications with control structures and weirs,

shoreline stabilization, and planting vegetation. A major objective for most projects was establishing desired vegetation for wildlife uses. Today, HREP projects are often constructed of sand dredged from the river, capped with fine sediment dredged from adjacent backwaters, and incorporated to form a soil base which will support the growth of desired vegetation. Over the years, plantings have included a variety of grasses, forbs, shrubs, and trees and often are planted with routine farming equipment and standard planting methods.

HISTORICAL VEGETATION STUDIES ON THE UPPER MISSISSIPPI RIVER

There are a number of studies related to the flora and vegetation of natural and artificial floodplain sites along the Upper Mississippi River in the St. Paul District. Studies have been conducted by universities, State Departments of Natural Resources, and Federal agencies. Four selected studies related to the floral composition of dredged material placement sites are summarized below. One common theme to all the studies is that sand dredged material placement sites are harsh environments that are difficult to revegetate and that exhibit early successional vegetation for many years.

In 1974 and 1975, Ziegler and Sohmer looked at the vegetation of 23 placement sites classified as to the age of the dredged material. Plant succession was a slow process in the environment provided by the dry, sandy dredged material. Since the sand was quite porous, low in nutrients, and subject to large fluctuations in temperature, it presented a very rigorous substrate for colonization by plants. Ziegler and Sohmer found that the colonizers of new dry dredged material were sedge, sand dropseed, purple sandgrass, and winged pigweed. Species that soon followed in succession included evening primrose, sweetclover, horseweed, brome, carpetweed, and clammyweed. Grape vines invaded the older sites. Ziegler and Sohmer found little change in species composition over a 20-year period. (S.R. Ziegler and S.H. Sohmer, November 1997, "The Flora of Dredged Material Sites in Navigation Pool 8 of the Upper Mississippi River." Waterways Experiment Station Technical Report D-77-31.)

In 1974, Larson of Winona State University conducted a study in Pool 5 for the Corps of Engineers. She seeded and/or fertilized four study plots. She found little difference between fertilized and unfertilized plots but did notice an effect on the growth of winged pigweed. Brome grass exhibited fast germination and lush early growth, but its long-term ability to survive was questioned. Larson suggested that dredging bottom mud onto the sand (now referred to as backwater dredging) would aid in correction of several of the problems involved in dredge spoil vegetation and would help establishment. (Debra L. Larson, 1974, "Vegetation of Dredge Spoil in the Lost Island Area of Pool 5." Winona State College, under contract with the Corps of Engineers.)

In 1974 and 1975, the University of Wisconsin at La Crosse conducted a study in Pool 8. They seeded reed canary grass, birds-foot trefoil, crown vetch, and sand reedgrass. None of the seeded species germinated. They also planted plugs of American beachgrass. The beachgrass maintained good growth rates during the study and expanded. ("Revegetation Study, Island 117, Navigation Pool No. 8, Upper Mississippi River," 1974-1975. Contribution No. 8, University of Wisconsin, La Crosse, River Studies Center.)

In 1975, Luther College in Iowa looked at the biota of several dredged material placement sites. Depending on the type of site, the most important plant species (on the basis of Importance Value) included sedge, smartweed, willow, sweetclover, sand dropseed, carpetweed, evening primrose, winged pigweed, pigweed, milkweed, and Virginia wild rye. (Greg McMahon, James Eckblad, et al., 1975, "The Impacts of Dredge Spoil Placement on the Upper Mississippi River," Grant No. EPP-7508419, Luther College, Decorah, Iowa.)

METHODS

This report summarizes the results of monitoring efforts from 1982 to 2000 for dredged material placement sites and HREP projects (see Figure 1). Most vegetation sites have been monitored on a regular basis since establishment. The monitoring normally consists of randomly selected quarter-square-meter plots on which percent cover and species composition are recorded. Importance values are calculated on the basis of frequency and dominance. Frequency, dominance, and importance value tables follow each site summary. Robel readings are also taken as a measure of vegetation height/density. See the Appendix for a description of the formulae used in the monitoring activities and a discussion of Robel measurements. An Analysis of Variance (ANOVA) was performed on total percent cover. Percent cover estimates are usually not normally distributed. The percent cover estimates were not transformed, so this may be a source of error. Random releve' plots were also taken recording species composition. Monitoring took place primarily in the fall, usually during August (see Table 1). Due to species phenology, this could affect the results. Memoranda containing the monitoring results have been prepared for each site and are on file at the St. Paul District.

A number of monitoring activities have been conducted on the project areas. The purpose of the monitoring is to determine the success of the plantings. To help assess this purpose, quarter-square-meter plots were randomly selected along a transect at each site. Early in the process, only total percent cover was estimated. Monitoring was expanded over the years to collect data on other variables. In later years, percent cover was estimated for the entire plot and also by species. A Robel pole was also used to estimate height/density relationships of vegetation within and between sites. A list of species observed while walking over the islands was also prepared. The species list was not a major portion of the monitoring, but it gave an indication of other species present. Species were identified to genus or species using standard plant taxonomy texts. Based on the objectives of the various projects, it did not seem to be necessary to identify all plants to the species level. No voucher specimens were taken.

The objectives for establishing vegetation on a site were to reduce erosion, provide cover for wildlife, and aesthetics. The objectives of the vegetation efforts were not always quantified and varied over the years. At each of the cover plots, Robel readings were taken to estimate the height-density relationship of the vegetation. A Robel reading of 1.5 decimeters after 2 years was identified as a goal of HREP projects. Robel readings are dependent on the species growth characteristics but do give an indication of vegetation density. An acceptable percent cover was not quantified. It was assumed that if the resulting cover was over 50% on capped sites it was successful. The vegetation efforts were also assumed to be a success if the seeded species grew. No

Table 1. Sampling Time of Monitoring Activities by Site

Year	Day	Month	Indian Slough		Peterson	Finger Lakes		Wabasha	Island 42	Weaver	Spring	Polander	Onalaska	Rosebud	Pool 8 Islands		Cold	Jackson	Wabasha	Lost	Crosby	Teepeeota	Island 58
			South	North	Lake	Disposal	Access	Prairie		Bottoms	Lake	Lake	Islands	Island	Phase 1	Phase 2	Springs	Island	Gravel Pit	Island	Island	Point	
1982	17	June																		X			
	5	August																		X			
1983	26	July																		X			
1984	9	August																		X			
1985	6 - 8	August																		X	X	X	
1986	4 - 7	August																X	X	X	X	X	X
1987	11 - 14	August																X	X	X	X	X	X
1988	15 - 19	August							X	X								X	X	X	X	X	X
1989	9-10 & 22-23	August							X	X								X	X	X	X	X	X
1990	7 - 9	August											X					X	X	X	X	X	X
	12	September								X													
1991	19 - 22	September								X			X	X	X								
1992	11 - 14	August								X			X		X								
1993	30 - 31	August											X		X								
	1 - 2	September								X													
1994	16 - 18	August							X				X		X		X						
1995	8 - 11	August	X			X				X	X	X	X		X								
1996																							
1997	9 - 11	September	X		X	X					X	X					X	X					
1998																							
1999	17 - 19	August	X	X	X	X	X				X	X	X	X		X							
2000	22 - 24	August						X								X							

objectives were quantified. Seeding rate is identified in the text by Pure Live Seed (PLS)/acre, lbs./acre, or bulk as noted.

Percent cover was estimated for each species on the plot. The frequency, relative frequency, dominance, relative dominance, and importance value were also calculated for each species. No criteria were developed for these variables for assessing the success of the growth of the vegetation. Photographs of the sites have been taken over the years in order to provide a photographic history of the monitoring activities. The vertical and most of the oblique aerial photographs were downloaded from the U.S. Geological Survey (USGS) Upper Midwest Environmental Sciences Center web site (www.umesc.usgs.gov). Other oblique photographs and all of the on-the-ground photographs are from the Corps of Engineers or U.S. Fish and Wildlife Service libraries. Photographs and data summaries follow each site discussion.

RESULTS OF VEGETATION MONITORING

The following vegetation sites monitored for this report are listed mainly in chronological order by date of construction or first major management activity (see Figure 1). The sites include channel maintenance and HREP activities. Information on each site includes site description and vegetation treatments, summary tables for percent cover, frequency, dominance, and importance value information collected during monitoring activities, Robel pole readings, vertical and oblique aerial photographs, and on-the-ground photographs taken during monitoring activities. The Appendix contains formulae used in the analysis, a discussion on using the Robel pole, results of soil analyses, and a list of common and scientific names of plant species used in this report. The identification of the long-term dredged material placement sites is from the St. Paul District's Channel Maintenance Management Plan (CMMP). (U.S. Army Corps of Engineers, "Channel Maintenance Management Plan." April 1996, St. Paul, Minnesota; see page 1, CMMP TAB 2, for a description of site designations.)

Lost Island, Pool 5, River Mile (RM) 744.7

Vegetation Measures

In 1982, the first relatively large-scale experiment with the vegetation of dredged material was conducted on the side slopes of the Lost Island Dredged Material Placement Site (5-744.7-LWT) in Pool 5 at River Mile (RM) 744.7. On May 14, 1982, an area of about 3 acres was broadcast seeded and hydromulched. Initially, the site was seeded with the following mixture (PLS designates pure live seed):

Species	Seeding Rate
red clover	8 lbs./ac.
yellow sweetclover	13 lbs./ac.
switchgrass, Blackwell	8 lbs. PLS/ac.
sand dropseed	8 lbs. PLS/ac.
annual rye	13 lbs./ac

The contractor also applied the following seed not specified in the original mix: brome, perennial rye, timothy, and birds-foot trefoil. The seeded area was fertilized at a rate of 600 lbs./ac. of 19-19-19 nitrogen-phosphorus-potassium (N-P-K). The fertilizer was applied with the hydromulch after the area was broadcast seeded. A control area was also established for comparison. A small test plot of annual rye was established at the southern end of the island by seeding 50 lbs./ac. of rye. No fertilizer or mulch was applied to this area.

On May 16, 1983, the downstream half of the hydromulched area was fertilized using a hand spreader at a rate of about 400 lbs./ac. of 19-19-19 (N-P-K). On May 22, 1985, about ½ acre of the hydromulched area on the downstream portion of the site was second seeded with the following seed mixture using a Cyclone seeder.

Species	Seeding Rate
blazer perennial ryegrass	10 lbs./ac.
switchgrass	1 lb. PLS/ac.
side oats grama	1 lb. PLS/ac.
little bluestem	2 lbs. PLS/ac.
big bluestem	1 lb. PLS/ac.
Canada wild rye	0.5 lb. PLS/ac.
crown vetch	2 lbs./ac.

Monitoring Results

Lost Island was monitored annually from the original seeding in 1982 through 1990 when most of the vegetation at the site was destroyed by heavy equipment (bulldozer tracks) and placement of additional channel maintenance dredged material. Percent cover estimates for the site are presented below.

Date	Percent Cover Seeded Area	Control Area
June 1982	6	1
August 1982	33	8
July 1983	12	16
August 1984	16	8
August 1985	20	4
August 1986	38	9
August 1987	45	20
August 1988	42	17
August 1989	42	12
August 1990	50	10

Figure 2 is a graphical presentation of the percent cover estimates between the seeded and control areas on Lost Island.

The site was visited 1 month after seeding in June 1982. Percent cover and species composition were similar between seeded and control areas. Species observed were typical of sand areas along the Upper Mississippi River: clammyweed, winged pigweed, pennycress, and hoary alyssum. Seeded species observed included red clover and sand dropseed, although sand dropseed is a natural invader on these sites.

The site was revisited in August 1982, with vastly different results as reflected in the percent cover estimates. Winged pigweed, an annual that readily invades sandy areas, represented most of the percent cover on the study plots, while grasses had the most stem density. The fertilizer had a tremendous effect, although it turned out to be only short term. The winged pigweed was about 20 inches tall and 2 feet in diameter on the fertilized area but only about 3 inches tall and 1 inch in diameter on the unfertilized control site. Other species observed included sand dropseed, red clover, rye, willow, lambsquarters, umbrella sedge, bindweed, spiderwort, quackgrass, and thistle.

Although winged pigweed is an annual plant, successional studies have shown that it can persist for a number of years. Sand dropseed is a perennial grass and usually maintains itself. The species composition between the seeded and control areas was essentially the same in 1983, although the height and density of the vegetation were greater in the seeded area.

In May 1983, a portion of the area was fertilized. Percent cover estimates are shown below. The fertilized area had less percent cover and fewer stems per sample plot (quarter-square-meter) than the unfertilized area. The vegetation in the fertilized area appeared less vigorous and more brown in color. At the time, Mr. Hollis Allen of the Waterways Experiment Station believed the fertilizer was applied too early and burned the vegetation; they have had similar experiences on their test plots (personal communication).

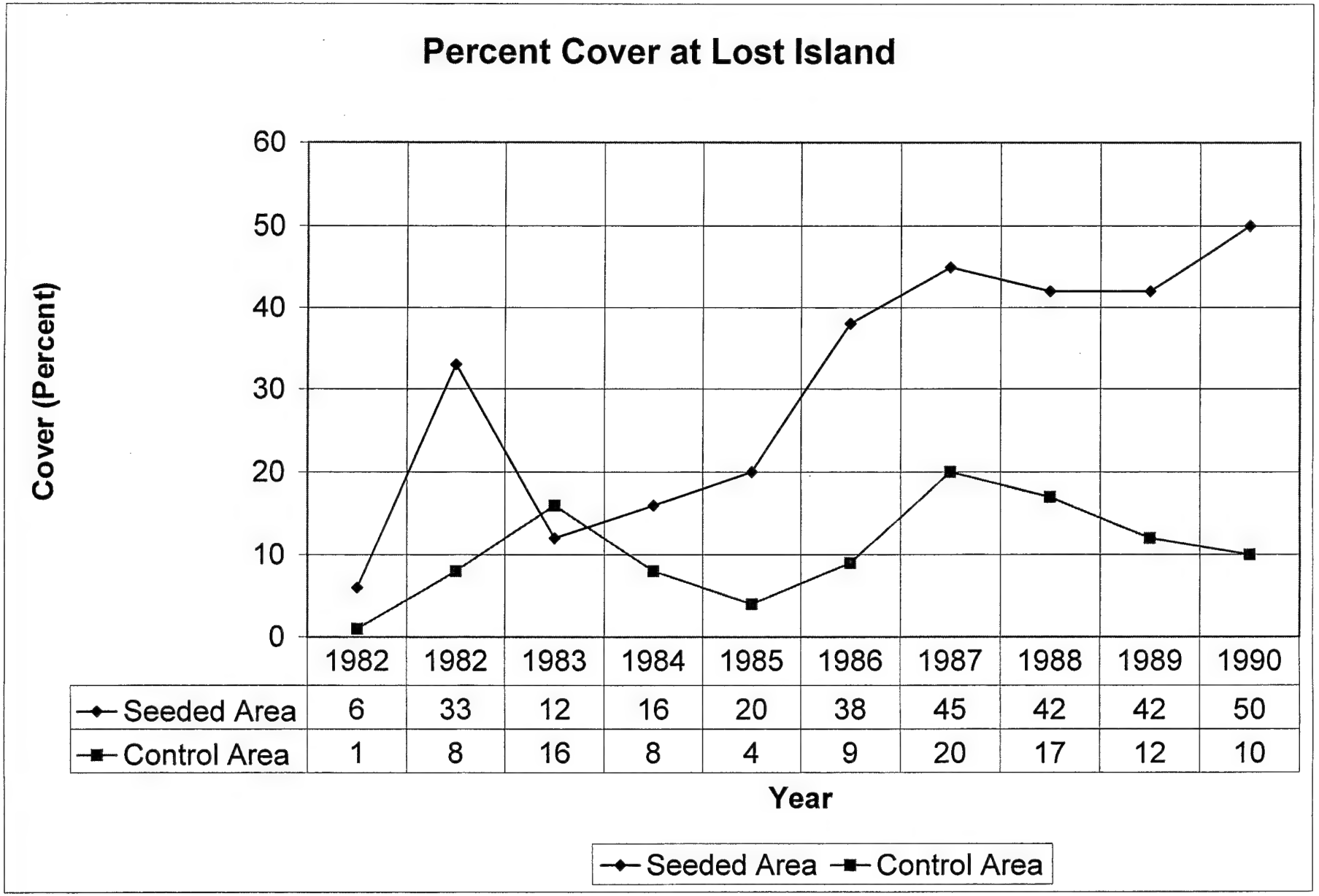


Figure 2. Percent cover estimates for Lost Island. High values for the second 1982 sample reflect effects of fertilizer and winged pigweed growth.

Treatment	Percent Cover	Stem Density
Hydromulched Area		
Fertilized	7	4
Unfertilized	16	12
Control Area	16	4

Over the years, percent cover increased on the seeded area and seemed to stabilize between 40% and 50%. Percent cover on the control area averaged about 15%. Between 1986 and 1990, percent cover seemed to reach its maximum. Canada wild rye, little bluestem, and crown vetch were recorded in years following the second seeding, but never in any great amount.

In 1985, the seeded area started to show an accumulation of litter, while the control area did not. Litter cover was estimated at about 8%.

The drought of 1987 and 1988 had little effect on the seeded area. The area exhibited a good growth of switchgrass and sand dropseed. The root systems of these species penetrated about 2 to 3 feet into the ground at the site.

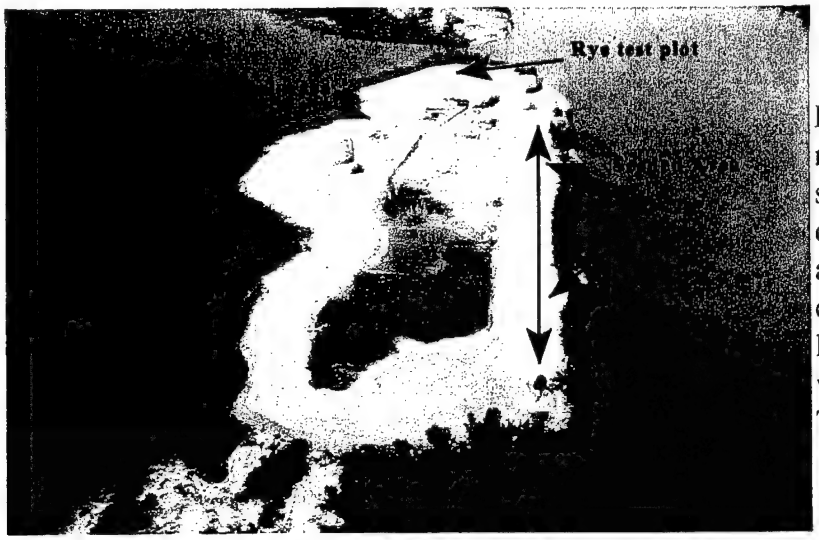
By 1990, most of the area was destroyed by reuse of the site for dredged material placement, and monitoring was terminated.

The test plot of annual rye germinated in 1982 but did not maintain itself. The rye became less dense over time and had essentially disappeared by 1985; the site was then abandoned.

Summary

The seeding of Lost Island was successful, although it took about 3 years before the seeded species started to appear and about 5 years before a good cover of about 40% developed. The dominant grass species were switchgrass and sand dropseed, both of which are natural invaders of sandy areas but usually take many decades before they reach the density found on Lost Island. After 7 years, the control area was still dominated by weeds such as winged pigweed and clammyweed. Sand dropseed was found on the control plots but was not as dense as on the seeded area. Direct placement of dredged material (sand) destroyed vegetation it covered. Disturbance from heavy equipment (bulldozer tracks) at the site had a tremendous negative impact on the vegetation. Such disturbance set the vegetation back to early successional stages; it is unlikely that vegetation on sandy sites would fully recover if such disturbance occurred frequently.

LOST ISLAND



Lost Island long-term dredged material placement site in Pool 5. The sand area on the right side of the disposal site was broadcast seeded and hydromulched in May 1982; a control area was established on the left side. The original hydromulch was green in color but quickly faded. The rye test plot was not mulched.

This photo was taken in June 1982 soon after seeding. The hydromulch can barely be seen on the side slope.

By August 1982, the effects of the fertilizer on the growth of winged pigweed were evident. Usually winged pigweed is about 6 inches tall and 2 inches in diameter. These plants are about 1 to 2 feet tall and up to 3 feet in diameter.

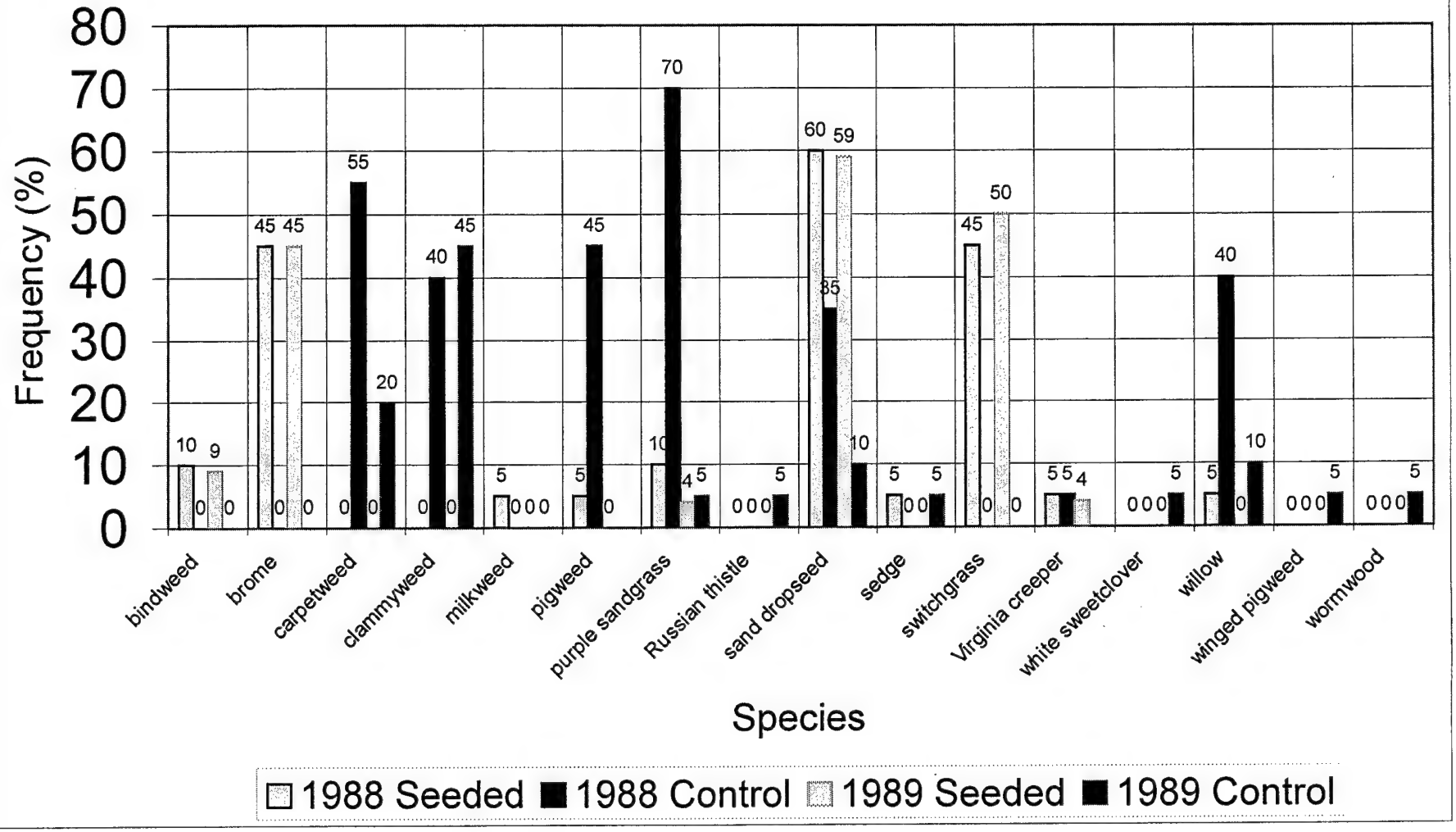
In August 1987, percent cover was 45%. Species included switchgrass, purple sandgrass, sand dropseed, brome, sedge, winged pigweed, and clover.

Percent cover in August 1989 was 42%. Switchgrass and sand dropseed were the dominant species. Percent cover over the four years from 1986 to 1990 averaged 45%. It appeared that percent cover would not exceed about 50% on bare sand sites.

Summary of Plot Data for Lost Island

	Species * seeded species	YEAR			
		Aug. 1988		Aug. 1989	
		Freq.	Rel. Freq.	Freq.	Rel. Freq.
	Seeded				
*	annual rye				
*	big bluestem				
	bindweed	10	5	9	5
	brome	45	23	45	26
*	Canada wild rye				
*	crown vetch				
*	little bluestem				
	milkweed	5	3		
*	perennial rye				
	pigweed	5	3		
	purple sandgrass	10	5	4	3
*	red clover				
*	sand dropseed	60	31	59	34
	sedge	5	3		
*	side oats grama				
*	switchgrass	45	23	50	29
	Virginia creeper	5	3	4	3
	willow	5	3		
*	yellow sweetclover				
	Average % cover	42		42	
	Control				
	carpetweed	55	19	20	17
	clammyweed	40	14	45	39
	pigweed	45	16		
	purple sandgrass	70	24	5	4
	Russian thistle			5	4
	sand dropseed	35	12	10	9
	sedge			5	4
	Virginia creeper	5	2		
	white sweetclover			5	4
	willow	40	14	10	9
	winged pigweed			5	4
	wormwood			5	4
	Average % cover	17		12	

Lost Island - Seeded vs. Control



Jackson Island, Pool 10, RM 644.5

Vegetation Measures

In late May 1984, fine sediment from dredging the auxiliary lock at Lock and Dam 9 was placed on a 1-acre site at the Jackson Island Dredged Material Placement Site (10-644.5-RIE) in Pool 10. The sediment contained a high amount of clay and dried to produce a very hard and cracked surface. Two treatments were established: a fine sediment site, and a sand site that did not receive fines. Both areas were broadcast seeded with the following mixture; seed could not be incorporated at the fine sediment site because sediments dried to a hard texture.

Species	Seeding Rate
switchgrass, ND 29	5.0 lbs. PLS/ac.
big bluestem, Sherburne Co. 1983	7.5 lbs. PLS/ac.
side oats grama, Killdeer variety	7.0 lbs. PLS/ac.
Indian grass, Anoka Co. 1983	7.5 lbs. PLS/ac.

The post-seeding environment was not ideal for germination either. About 2 weeks after seeding, high water flooded the area.

No management activities have been undertaken at this site.

Monitoring Results

Total percent cover was estimated for both sites (see table below and Figure 3).

	Percent Cover	
Date	Fine Sediment	Sand Sediment
August 1986	92	38
August 1987	77	48
August 1988	38	23
August 1989	91	34
August 1990	92	38
September 1997	80	52

Robel readings were taken in 1997 only. A Robel reading of 6.0 decimeters was recorded on the fine sediment site, while a reading of 1.0 decimeter was recorded on the sand site.

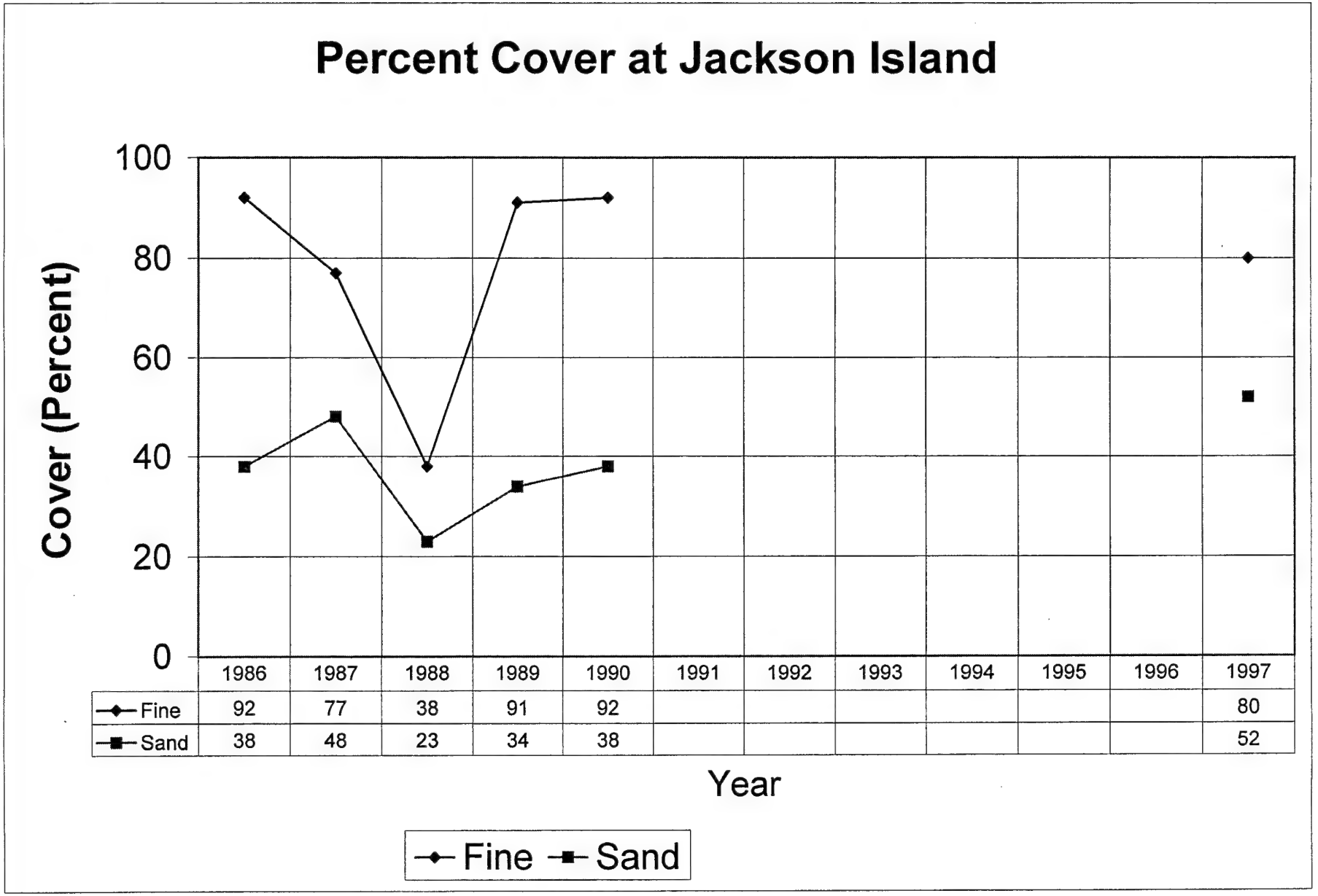


Figure 3. Percent cover estimates for Jackson Island.

The Jaccard Index of Species Similarity was calculated for the fine and sand areas from 1986 to 1997 and is summarized below. The high Index indicates that the sites have many species in common.

Date	Jaccard Index
August 1986	33
August 1987	67
August 1988	33
August 1989	53
August 1990	28
September 1997	12

Species importance values were obtained for 1997 only. The results are as follows:

Treatment	Species
Fine Topsoil	big bluestem
	Indian grass
Sand Topsoil	side oats grama
	big bluestem
	paspalum and brome

Summary

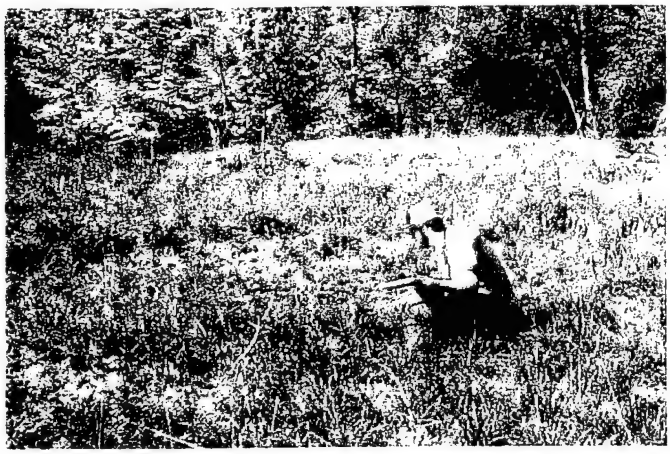
During the first 2 years after seeding, cottonwood and weedy grass species such as smartweed, thistle, lambsquarters, pigweed, bindweed, and horseweed dominated the sites. Subsequently, seeded species including big bluestem, side oats grama, and Indian grass became established on the fine sediment site. Over the years, side oats grama declined in abundance and switchgrass, another seeded species, increased in abundance. The fine sediment site has always had a higher percent cover than the sand sediment area; however, both areas contain seeded species and have attained desired results. The percent cover on the sand site is similar to the results observed at other sand areas on the Upper Mississippi River.

JACKSON ISLAND

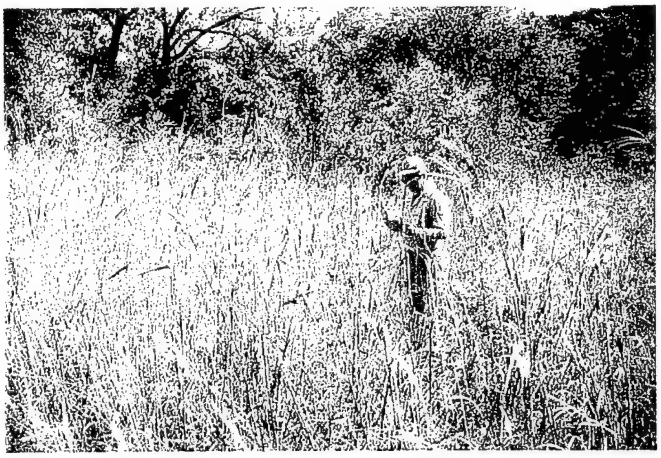
Jackson Island dredged material placement site in Pool 10. Fine material dredged from an auxiliary lock chamber was used to cap sand on a portion of the site.

Jackson Island was broadcast seeded in May 1984. A fine material area and a sand area were seeded. Both areas were flooded a few weeks after seeding.

Side oats grama in August 1989.



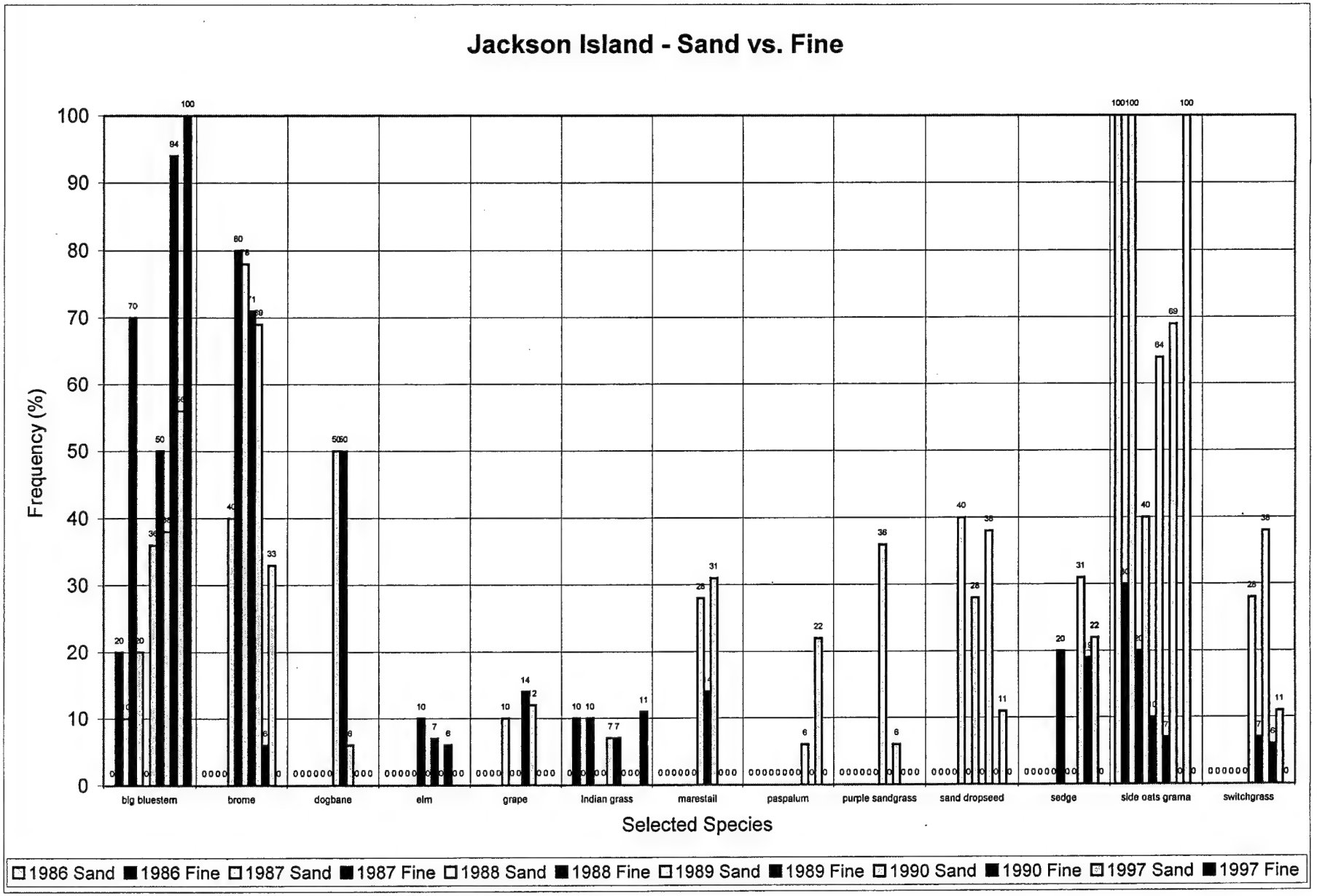
In August 1988, the Sand Area shown in this photo had 23% cover. The dominant species were brome, sedge, and side oats grama. The Fine Sediment Area had 38% cover in 1988 with big bluestem, brome, sand dropseed, and side oats grama dominant.



In August 1997, the Sand Area had 52% cover dominated by side oats grama, big bluestem, and brome. The Fine Material Area shown in this photo was dominated by big bluestem and Indian grass with 80% cover.

Summary of Plot Data for Jackson Island

	Species	YEAR												
		Aug-86	Aug-87	August 1988		August 1989		August 1990		September 1997				
	* seeded species	Freq.	Freq.	Freq.	Rel. Freq.	Freq.	Rel. Freq.	Freq.	Rel. Freq.	Freq.	Rel. Freq.	Dom.	Rel. Dom.	I.V.
	Sand													
*	big bluestem		10	20	13	36	9	38	11	56	22	13	24	23
	brome			40	27	78	20	69	20	33	13	2	8	8
	dogbane					50	13	6	2					
	flatweed					7	2							
	foxtail					7	2							
	goosefoot					7	2							
	grape			10	7			12	4					
*	Indian grass					7	2							
	marestail					28	7	31	9					
	paspalum							6	2	22	9	4	9	9
	purple sandgrass					36	9	6	2					
	quackgrass					7	2							
	sand dropseed			40	27	28	7	38	11	11	4	0.2	2	2
	sedge							31	9	22	9	1	5	5
*	side oats grama	100	100	40	27	64	16	69	20	100	39	31	59	49
*	switchgrass					28	7	38	11	11	4	2	3	4
	Average % cover	38	48	23		34		38		52				
	Robel (decimeters)									0.7				
	Fine													
*	big bluestem	20	70			50	13	94	56	100	90	74	93	92
	bindweed					14	4							
	brome			80	67	71	18	6	4					
	dogbane					50	13							
	elm			10	8	7	2	6	4					
	goosefoot					7	2							
	grape					14	4							
	gumweed					7	2							
*	Indian grass	10	10			7	2			11	10	6	7	9
	marestail					14	4							
	mint					21	5	6	4					
	quackgrass					100	25	19	11					
	reed canary grass							6	4					
	sedge			20	17			19	11					
*	side oats grama	30	20	10	8	7	2							
	sorrel					7	2							
*	switchgrass					7	2	6	4					
	Virginia creeper							6	4					
	Average % cover	92	77	38		91		92		80				
	Robel (decimeters)									6.4				


Jackson Island - Sand vs. Fine
Frequency (%)
Selected Species
big bluestem
brome
dogbane
elm
grape
Indian grass
marestail
paspalum
purple sandgrass
sand dropseed
sedge
side oats grama
switchgrass
1986 Sand
1986 Fine
1987 Sand
1987 Fine
1988 Sand
1988 Fine
1989 Sand
1989 Fine
1990 Sand
1990 Fine
1997 Sand
1997 Fine

Teepeeota Point, Pool 4, RM 757.5

Vegetation Measures

The Teepeeota Point Dredged Material Placement Site (4-757.5-LW) was the first large-scale attempt to place fine material on top of sand to create a more suitable substrate (soil) for the growth of vegetation. Teepeeota Point is a confined dredged material placement area used periodically for the placement of dredged material and receives fairly heavy human use (recreational beach/camping).

Teepeeota Point was divided into two treatments: a fine sediment site and a control (sand) site. In August and September 1984, fine material was dredged from a backwater area near the site using a small 8-inch hydraulic Mud Cat dredge and pumped onto the site through an 8-inch pipe. The first method of placement involved cutting holes in the discharge pipe to allow the fine material to flow onto the sand, but this caused erosion of the side slopes of the placement site. The next method tried involved excavating small pits and pumping the fine material into them; however, the sandy pits quickly sealed with fine sediment and the discharge soon overflowed and eroded the site.

The final method used an irrigation sprayer that was dead-headed to a bulldozer and automatically retrieved from up to 600 feet away using a winch. This procedure sprayed the fine sediments across the sand; it appeared to allow the fine material to dry slightly and the water to soak away or run off between applications of the fine material without causing erosion problems. This method appeared to be capable of applying a couple of inches of fine material on the sand, although it became obvious that it would take some time to achieve a thickness of 2 inches of material. Unfortunately, the dredging contract was expiring and it was not possible to apply more than about 1/4 inch of fine material over the area. The spray equipment was removed and dredged material was pumped directly into the bottom of the placement site where it accumulated to a thickness of at least 6 inches.

No vegetation seeding was conducted at the site.

Monitoring Results

Even though only about 1/4 inch of fine material was placed on the side slopes of the placement site, it appeared that this was enough to produce at least some short-term benefits for enhancing the growth of vegetation. In contrast to bare sand, the main advantage of the fine sediment was that it provided organic material which retained moisture and contributed to the growth of the vegetation. The percent cover estimates for the treated and control sites at Teepeeota Point are shown below.

Date	Percent Cover	
	Treated Area	Control Area
August 1985	20	4
August 1986	20	8
August 1987	16	10
August 1988	14	0
August 1989	14	8
August 1990	16	6

Figure 4 is a graphical presentation of the percent cover estimates between the control and fine material areas.

The species composition between the treated and control areas was similar. Species present included sand dropseed, sedge, purple sandgrass, marestail, clammyweed, winged pigweed, thistle, mustard, and Canada wild rye. On the basis of the limited data, average percent cover was higher on the fine sediment site (17%) than on the control site (6%). However, the percent cover declined on the fine sediment site over the years; it was observed that the fine material was less abundant in the surface layer and was probably being incorporated into the sand as the years passed.

The Jaccard Index of Species Similarity for 1988, 1989, and 1990 was 28, 40, and 44, respectively, between the fine treatment area and the control area. The sites have a fair number of species in common, which may indicate that not enough fine material was placed to make a significant difference in species composition.

As noted, the bottom of the placement site accumulated over 6 inches of fine material from the excess dredging. Total percent cover in this area was about 80% and contained a wide variety of species. The vegetation in this area was dense and vigorous. The high cover persisted until the site was used for dredged material placement in 1986 and the fine material was covered with sand.

Summary

Placing fine material, even a small amount, enhanced the growth of vegetation. The irrigation sprayer appeared to be a fairly effective method of placing the fine material. However, it required some specialized equipment and was probably more time-consuming than traditional methods such as direct hydraulic pumping or mechanically off-loading material from barges. There also was some doubt whether enough fine material (4 to 6 inches was desired) could be sprayed on Teepeeota Point to produce an adequate seed bed and good vegetative growth.

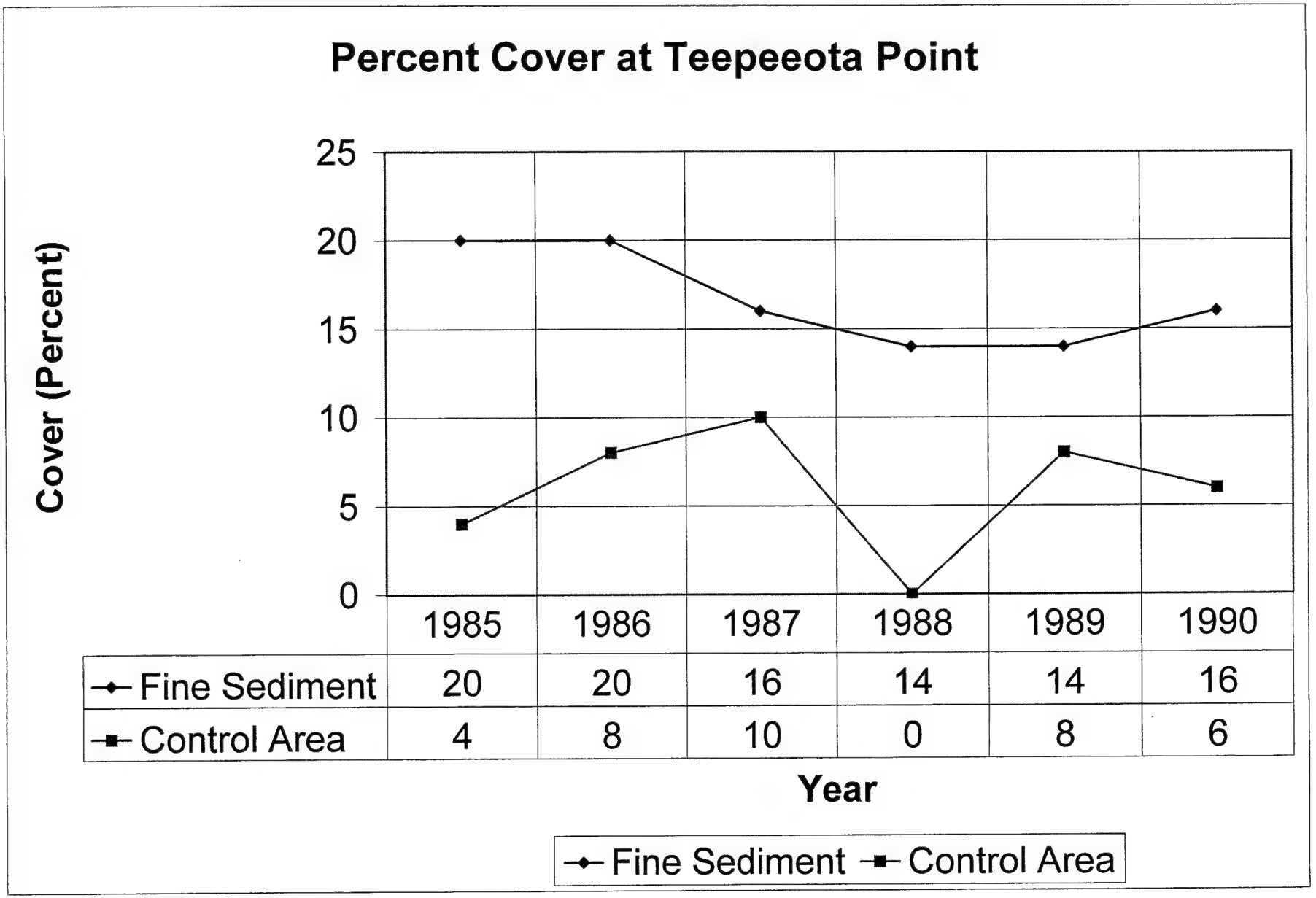
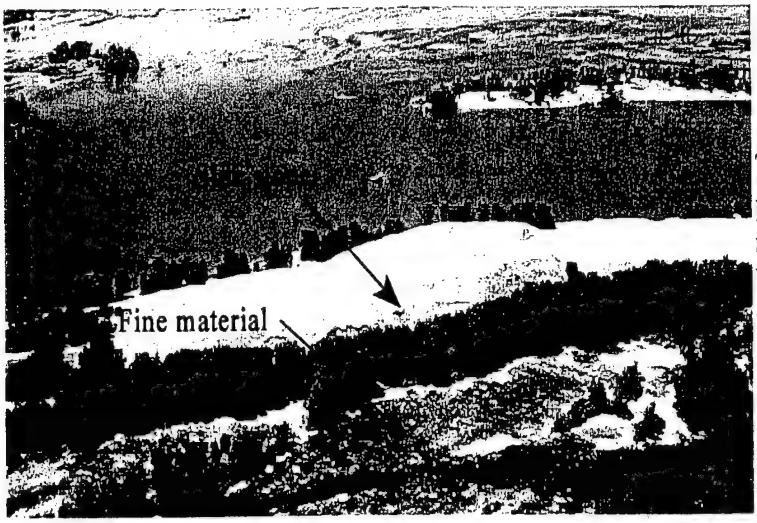


Figure 4. Percent cover estimates for Teepeeota Point.

TEEPEEOTA POINT



Teepeeota Point dredged material placement site in Pool 4. Fine material was dredged from the backwater area at the bottom of this photo and placed on the sand side slope using an irrigation sprayer.

This was the District's first attempt to place fine material on a large area of sand. In August and September 1984, various techniques were tried to place fine material. An irrigation sprayer was used to apply the fine material dredged from the backwater area shown in the above photo.

The contract was about to expire in September 1984 so only about 1/4 inch of fine material was applied to the site. It was not incorporated, just placed on top of the sand. The bulldozer and irrigation sprayer can be seen in the distance. The bulldozer was used to drag the sprayer back and forth over the site.

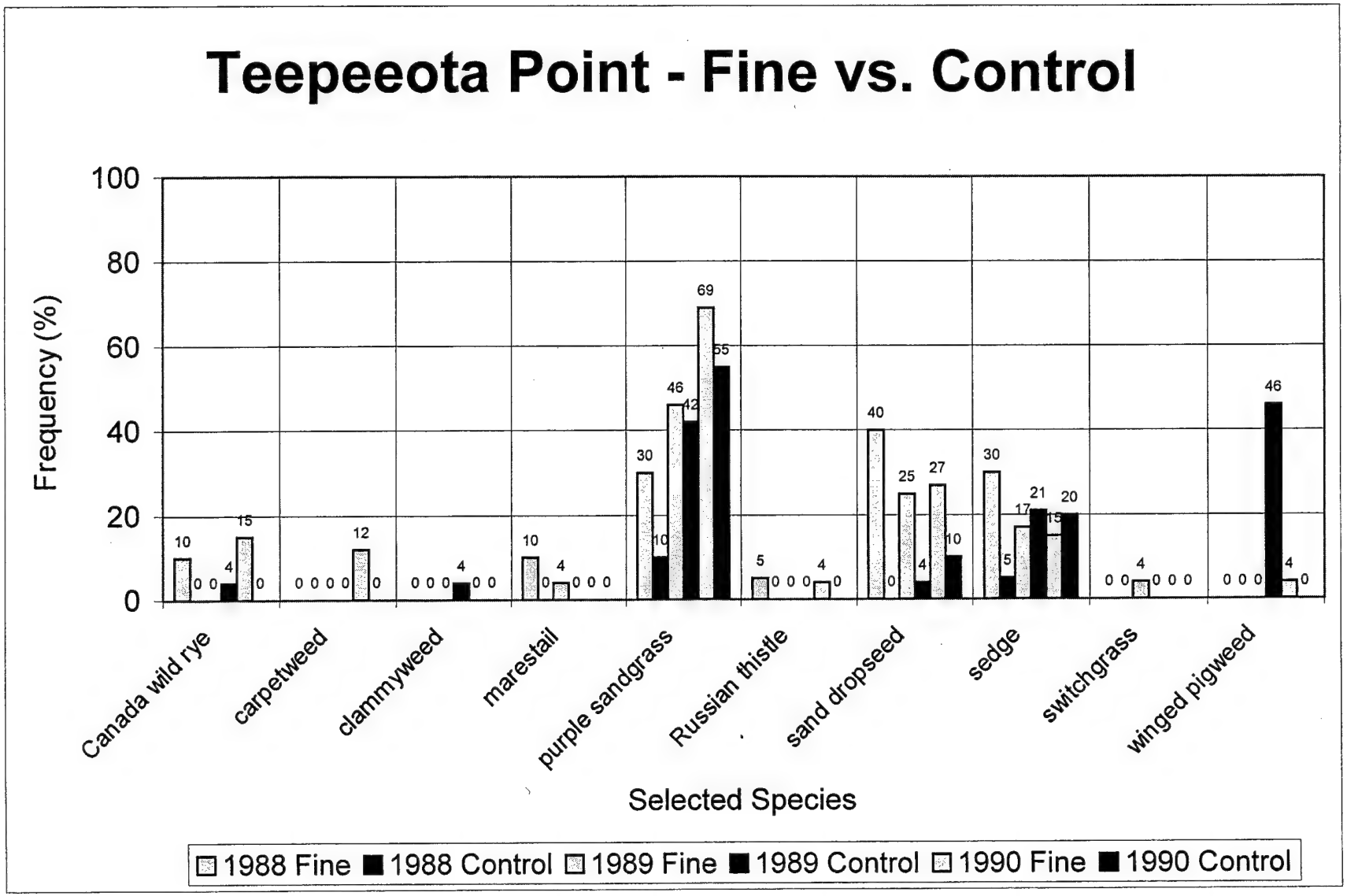
TEEPEEOTA POINT

The site was not seeded. In June 1985, one year after applying the fine material, the site had 20% cover while the corresponding control area had 4% cover. Fine material could still be seen on the surface. Winged pigweed, clammyweed, sedge, and carpetweed were typical species. Excess fine material was placed in the bottom of the placement site (not shown). Vegetation in that area was dense with 80% cover.

In August 1988, percent cover was 14% compared to 0% at the control area. Sand dropseed was present near the top of the slope and early successional species were still common. Even a small amount of fine material on sand seemed to enhance the growth of vegetation.

Summary of Plot Data for Teepeeota Point

Species	YEAR					
	August 1988		August 1989		August 1990	
	Freq.	Rel. Freq.	Freq.	Rel. Freq.	Freq.	Rel. Freq.
Fine Area						
Canada wild rye	10	8			15	10
carpetweed					12	8
daisy fleabane	5	4				
glasswort			12	12	8	5
marestail	10	8	4	4		
purple sandgrass	30	23	46	42	69	45
Russian thistle	5	4			4	2
sand dropseed	40	31	25	23	27	18
sedge	30	23	17	15	15	10
switchgrass			4	4		
winged pigweed					4	2
Average % cover	14		14		16	
Control						
Canada wild rye			4	3		
clammyweed			4	3		
glasswort			25	17	30	25
purple sandgrass	10	67	42	28	55	46
sand dropseed			4	3	10	8
sedge	5	33	21	14	20	17
sumac			4	3	5	4
winged pigweed			46	30		
Average % cover	0		8		6	


Teepeeota Point - Fine vs. Control
Frequency (%)
100
80
60
40
20
0
Canada wild rye
carpetweed
clammyweed
marestail
purple sandgrass
Russian thistle
sand dropseed
sedge
switchgrass
winged pigweed
Selected Species
1988 Fine
1988 Control
1989 Fine
1989 Control
1990 Fine
1990 Control

Alma Marina, Pool 4, RM 754.0

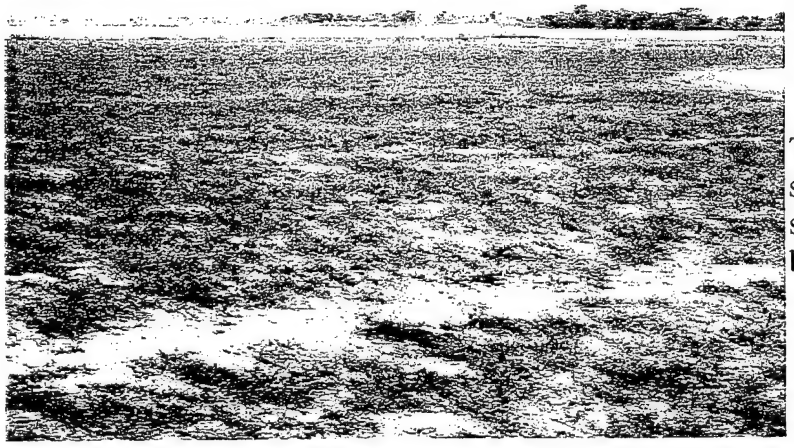
As a beneficial use of channel maintenance dredged material, sand was placed at the Alma Marina to create a recreation area for softball, volleyball, and similar activities. In the fall of 1985, the City of Alma, Wisconsin, placed 8 inches of clay on top of the sand and drill seeded rye, fescue, and bluegrass at the rate of 80 lbs./ac.

Visual monitoring for a few subsequent years showed that the area produced a fairly heavy growth of alfalfa and bluegrass, exceeding 70% cover. The area is now mowed and used for recreational activities.

ALMA MARINA

Alma Marina vegetation site in Pool 4 at Alma, Wisconsin. Fine sediment was placed on the site in 1995 and seeded.

By May 1986, grasses had germinated from the previous fall seeding of rye, fescue, and bluegrass.



This August 1988 photo shows the site as a mowed field. The site was subsequently developed into a baseball field.

Crosby Island, Pool 8, RM 690.4

The Crosby Island Dredged Material Placement Site (also called Above Brownsville Site 8-690.4-LWT) was a confined placement site located in Pool 8 near Brownsville, Minnesota. Three different vegetation studies have been conducted at this site: two by the Corps of Engineers and the Fish and Wildlife Service, and one by the University of Wisconsin at La Crosse. These studies are described below.

1974 Study

On May 28, 1974, Dr. Thomas Claflin of the University of Wisconsin at La Crosse planted American beachgrass stolons on a low, flat area near the downstream end of the present confined placement site. In the 25 years since planting, these plants have expanded vegetatively over 300 feet from the original plantings. The beachgrass has formed a dense, almost monotypic mat. The expansion is entirely vegetative because a sterile strain of American beachgrass was used. In 1985, a small portion of the beachgrass plantings was burned by what appeared to be fireworks. By 1986, vegetation reestablished itself and the effects of the fire were not apparent.

1985 Study

On May 21, 1985, approximately 3/4 acre of the sandy side slope of the placement site was broadcast seeded with the following seed mixture. After the seed was broadcast, a fence was pulled over the area to incorporate the sand and seed.

Species	Seeding Rate
blazer perennial ryegrass	15 lbs./ac.
switchgrass	2 lbs. PLS/ac.
side oats grama	3 lbs. PLS/ac.
little bluestem	4 lbs. PLS/ac.
big bluestem	3 lbs. PLS/ac.
Canada wild rye	1.5 lbs. PLS/ac.
crown vetch	3 lbs./ac.

Early successional species such as purple sandgrass, clammyweed, winged pigweed, and sedge were well represented at the site and occur naturally on sandy areas on the Upper Mississippi River. The only seeded species that became established at the site was Canada wild rye. The amount of vegetation at the site was low, but the Canada wild rye present appeared vigorous. In early years, some little bluestem was observed at the bottom of the side slope near a backwater of the river; however, this species did not persist.

Percent cover estimates for the site are shown below and on Figure 5.

	Percent Cover	
Date	Seeded Area	Control Area
August 1985	1	4
August 1986	4	1
August 1987	6	0
August 1988	9	1
August 1989	16	2
August 1990	14	2

The seeded area did not attain much cover. The Jaccard Index of Species Similarity between the seeded and control areas for the years 1988, 1989, and 1990 was 33, 44 and 71, respectively. The high index would tend to indicate that not many of the seeded species germinated and the sites are fairly similar in species composition. The site was observed in 1999 and it still exhibited limited cover. Bare sand does not appear to be a good substrate for grass vegetation.

1986 Study

Until 1986, it did not appear that beachgrass planted in the 1975 study would invade the side slope of the placement site. On April 30, 1986, about 120 stolons of beachgrass taken from the original 1975 planting were transplanted to the side slope of the placement area to see if the species would colonize higher, drier sites. In the fall of 1986, it appeared that all of the transplants were dead or even pulled out by recreationists that use the island. In 1987, two plants were found growing at the site; by 1990, it was estimated that over 350 beachgrass plants were growing. In 1999, beachgrass continued to expand up- and down-slope, and individual plants were too numerous to count.

Summary of Studies

Seeding of bare sand did not produce a dense cover of vegetation. The seeded area still has 80% to 90% exposed sand. Beachgrass from the 1975 planting continues to thrive at the site and expand its distribution; it has formed a monotypic stand with little or no competition from other species. Transplanted beachgrass from the 1986 study continues to expand, although it appears to expand more slowly on the side slopes than on the lower flat areas of the site. It is anticipated that beachgrass from both sites will eventually merge (about 300 feet of separation now) and continue to expand its distribution on Crosby Island in the absence of human disturbance (recreation and/or placement of dredged material).

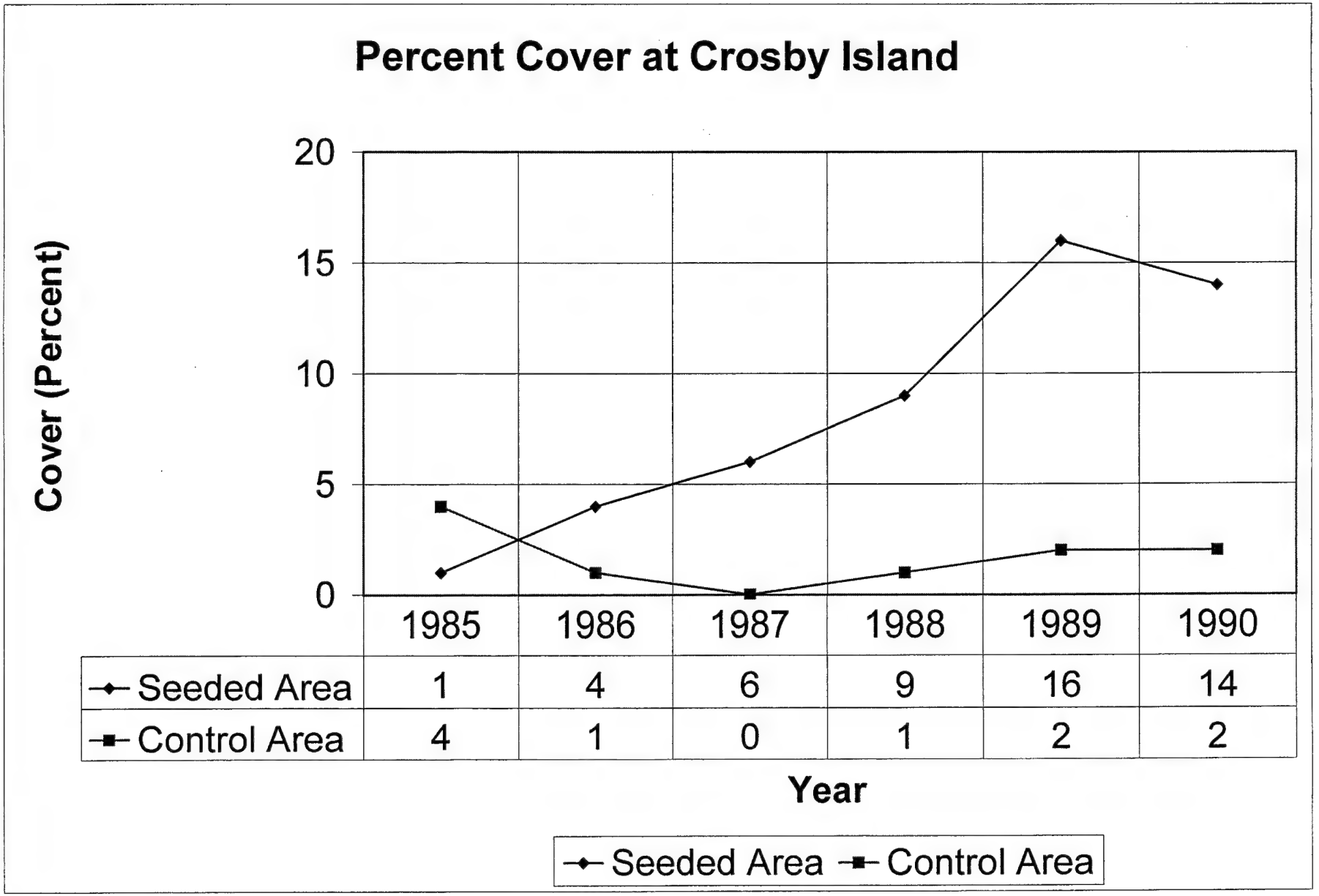


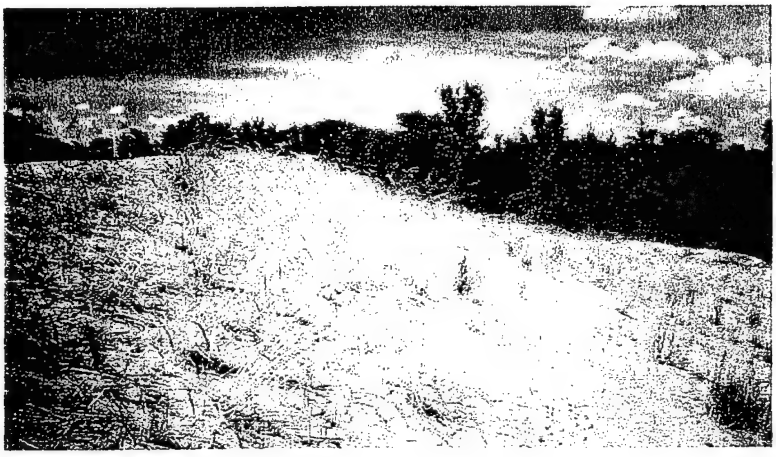
Figure 5. Percent cover estimates for Crosby Island.

CROSBY ISLAND

July 1987, photo of Crosby Island dredged material placement site in Pool 8. 1974 beachgrass plantings by the University of Wisconsin-La Crosse are shown at lower left center of photo. COE/FWS seeded area and beachgrass transplanting sites indicated at the right center.

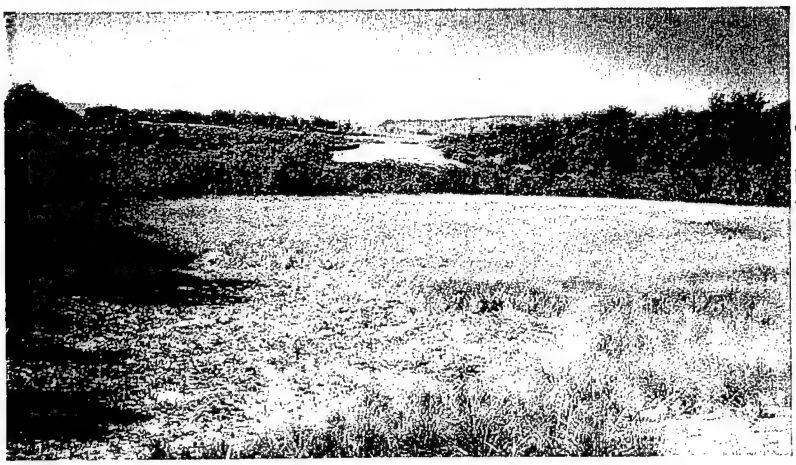
In May 1985, a small area of sand was broadcast seeded and a fence pulled over the area to incorporate the seed.

In August 1988, overall percent cover was 9%. Canada wild rye germinated well near the top of the slope.



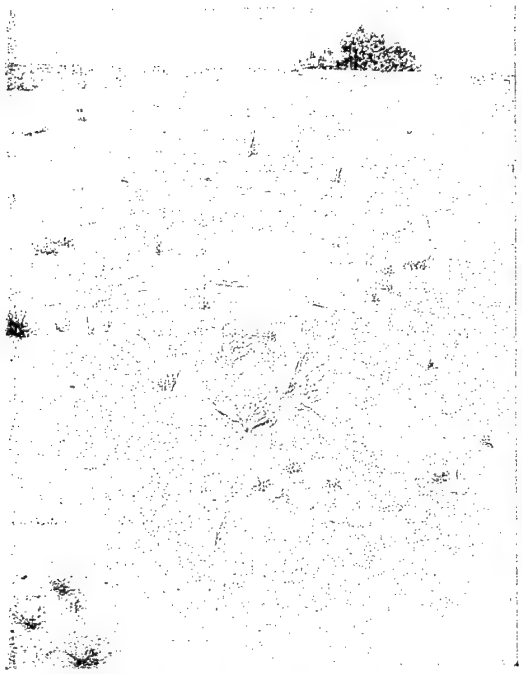
In August 1990, percent cover was 14%. The densest growth was near the top where the Canada wild rye grew.

CROSBY ISLAND

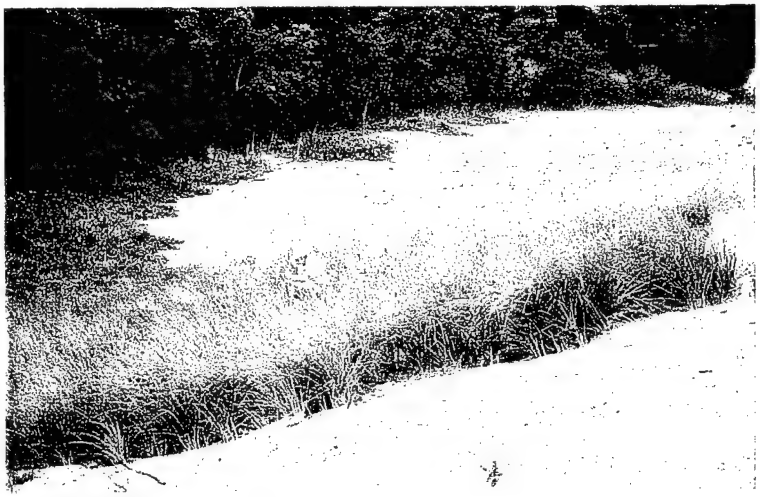


This September 1985 photo shows the effects of fire, probably caused by fireworks, on the 1974 beachgrass plantings. No effect could be seen a year or two later and the plantings continued to expand on the site.

In April 1986, about 120 beachgrass sprigs were transplanted from the 1974 planting to the side slope of the disposal site. Until that time, it did not appear that the beachgrass would colonize the side slopes very quickly.



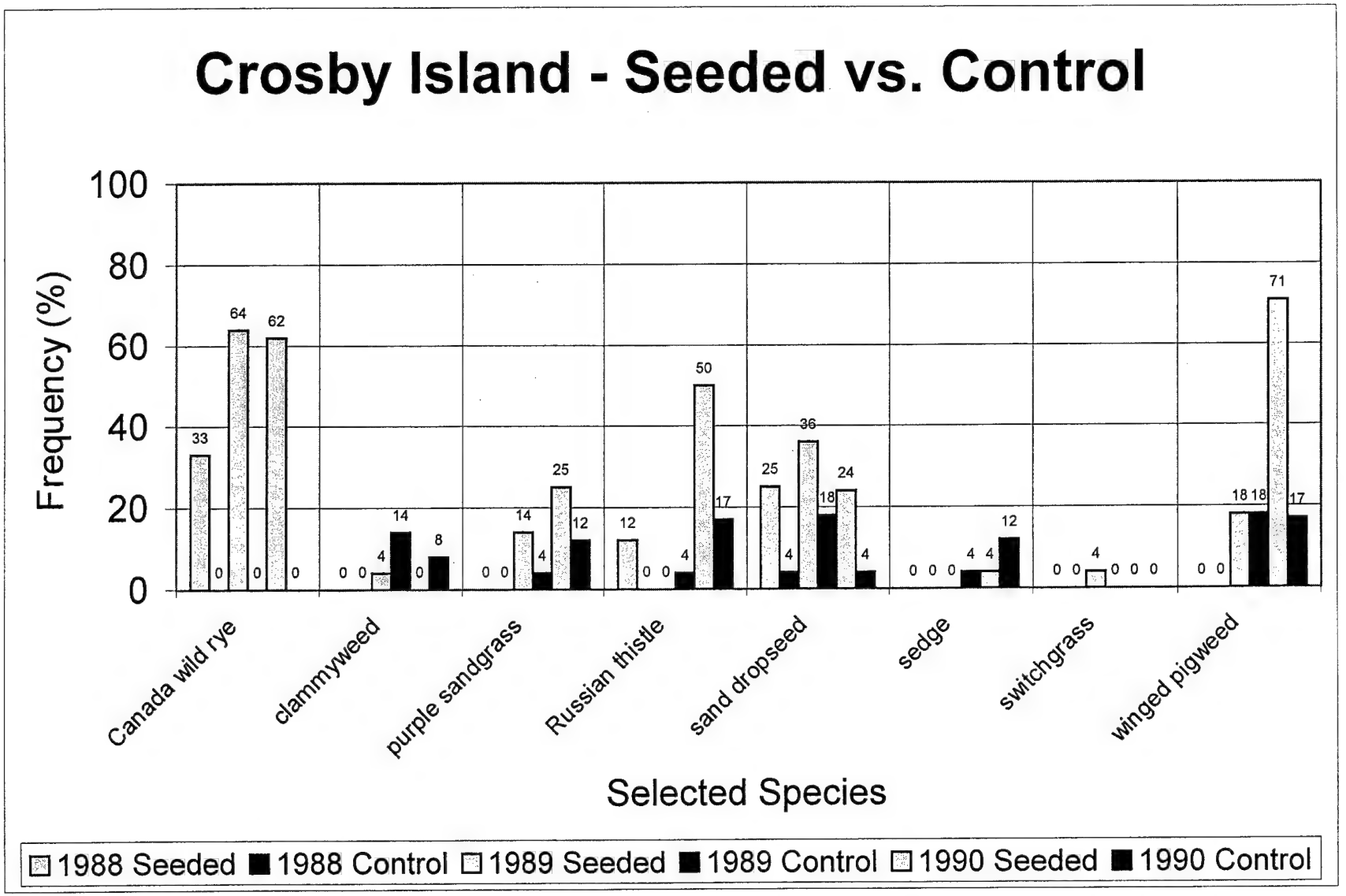
In August 1986, most of the beachgrass sprigs appeared to have been pulled from the sand or dead. Some green sprigs can be observed in the photo.



In this 1990 photo, over 350 sprigs were counted in the transplant area. By August 1995, there were many times that number. The beachgrass continued to expand and by 1999 were too numerous to count.

Summary of Plot Data for Crosby Island

	Species * seeded species	YEAR					
		August 1988		August 1989		September 1990	
		Freq.	Rel. Freq.	Freq.	Rel. Freq.	Freq.	Rel. Freq.
	Seeded						
*	big bluestem						
*	Canada wild rye	33	47	64	44	62	26
	clammyweed			4	3		
*	crown vetch						
*	little bluestem						
*	perennial rye						
	purple sandgrass			14	9	25	10
	Russian thistle	12	18			50	21
	sand dropseed	25	35	36	25	24	10
	sedge					4	2
*	side oats grama						
*	switchgrass			4	3		
	willow			4	3		
	winged pigweed			18	12	71	30
	Average % cover	9		16		14	
	Control						
	clammyweed			14	21	8	12
	purple sandgrass			4	7	12	18
	Russian thistle			4	7	17	24
	sand dropseed	4	100	18	28	4	6
	sedge			4	7	12	18
	winged pigweed			18	28	17	24
	Average % cover	1		2		2	


Crosby Island - Seeded vs. Control
Frequency (%)
100
80
60
40
20
0
33
0
64
0
62
0
0
0
4
14
0
8
0
0
14
4
25
12
12
0
0
4
50
17
25
4
36
18
24
4
0
0
0
4
4
12
0
0
4
0
0
0
0
0
18
18
71
17
Canada wild rye
clammyweed
purple sandgrass
Russian thistle
sand dropseed
sedge
switchgrass
winged pigweed
Selected Species
1988 Seeded
1988 Control
1989 Seeded
1989 Control
1990 Seeded
1990 Control

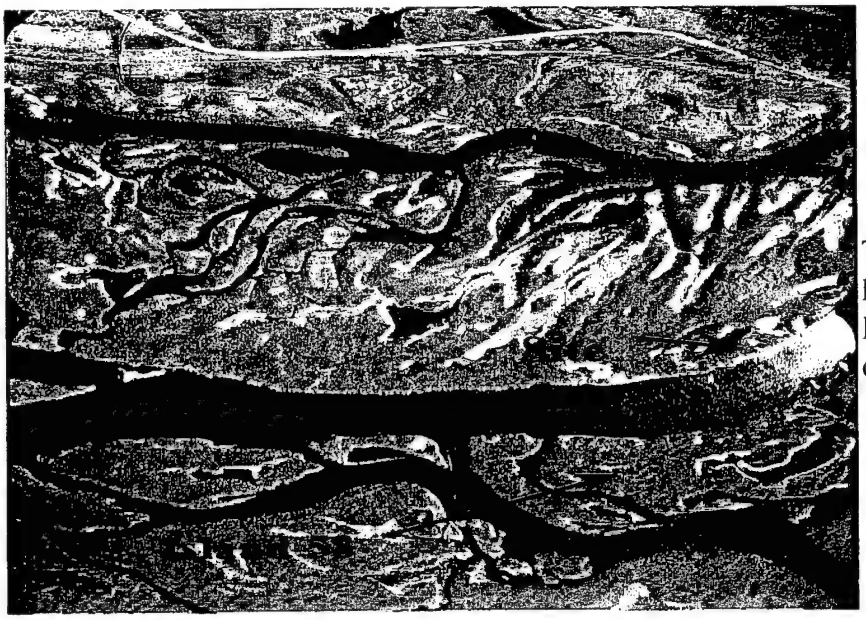
Island 58, Pool 5A, RM 734.5

The Island 58 Dredged Material Placement Site (5A-734.5-LWE) was a small dredged material placement site surrounded by a dense stand of floodplain forest in Pool 5A near Alma, Wisconsin. Island 58 has been the site of a couple of vegetation activities. In 1985, fine sediment from a minor dredging activity at Lock and Dam 5A was deposited at the site; the site was not seeded.

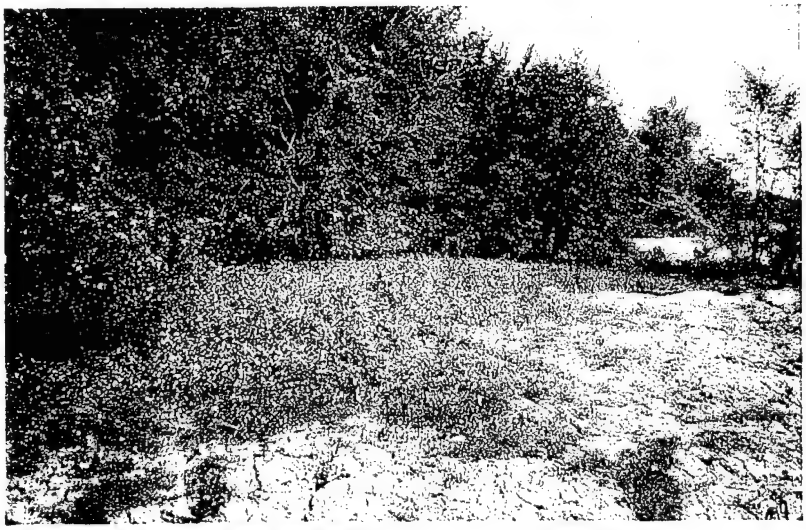
The site was monitored in August between 1985 and 1990. During the first few years, the site was dominated by reed canary grass, cottonwood, and willow. Percent ground and overhead cover was essentially 100% during the entire monitoring period. By 1990, the site had revegetated naturally into a dense forest of cottonwood approximately 15 to 20 feet in height. For comparison, fine sediment from a similar dredging activity in 1984 at Lock and Dam 9 was placed at the Jackson Island Site in Pool 10; initial growth was dominated by an abundance of similar cottonwood seedlings. However, in that case, cottonwoods were replaced by the seeded prairie grasses over time. In contrast, fine sediments placed at the Island 58 site revegetated naturally with woody vegetation.

In 1999, an area at Island 58 was planted with trees. Rooted stock about 1 to 2 feet tall was planted, some with tree shelters and tree mats. Species included swamp white oak, green ash, silver maple, and hackberry.

ISLAND 58



The Island 58 site is actually located across the river from Island 58 at the arrow (east side of river).



August 1985, soon after the fine material was placed on the sand site. The site was not seeded. Reed canary grass was common.

August 1986, one year later. Cottonwood and willow were the dominant species.

ISLAND 58

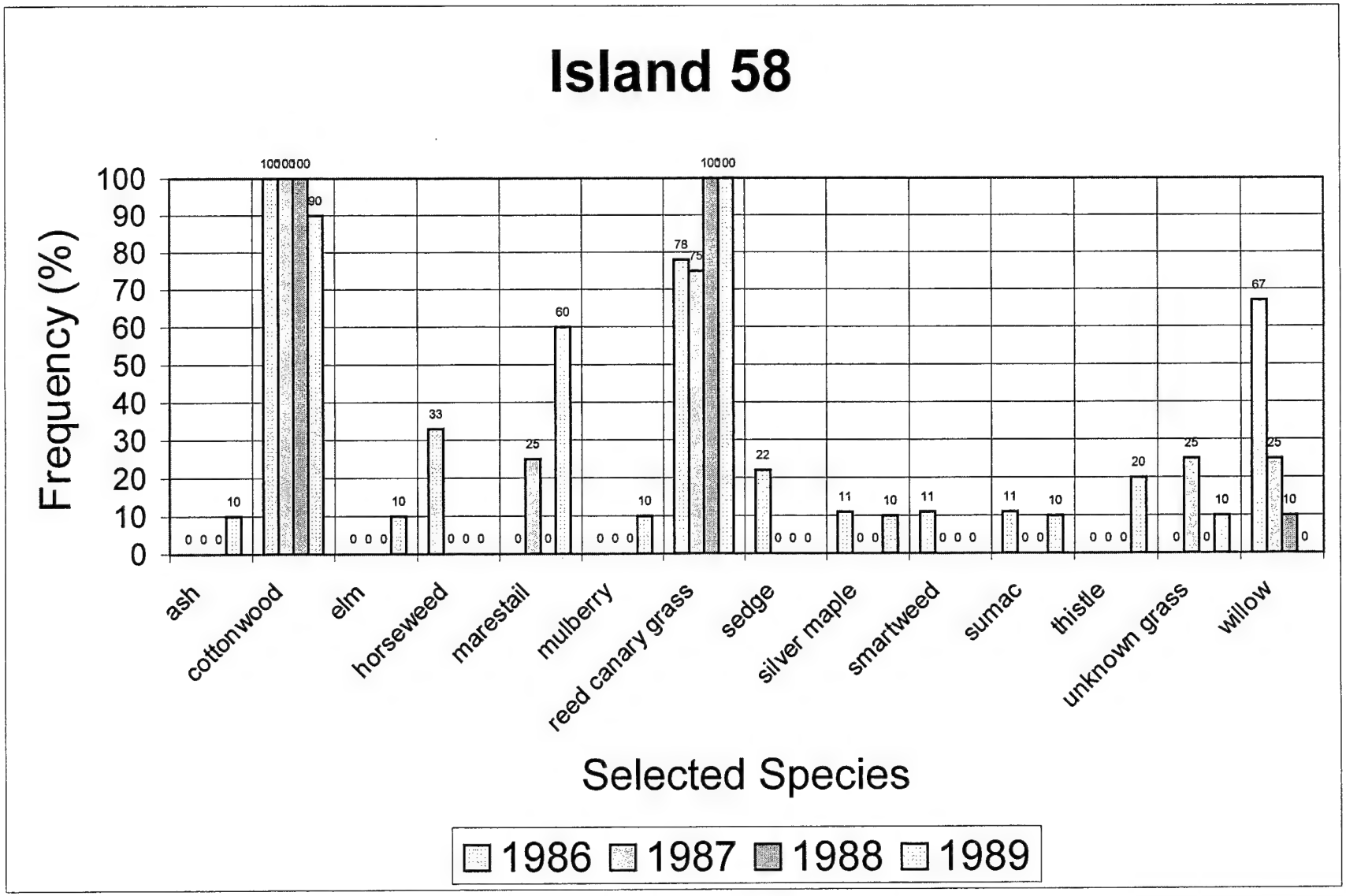
August 1987, two years after placement of fine material. Cottonwood had taken over the site and was about 10 to 12 feet tall.

August 1989. Cottonwood was still the dominant component.

August 1990. The site has reverted to a forest.

Summary of Plot Data for Island 58

Species	YEAR							
	August 1986		August 1987		August 1988		August 1989	
	Freq.	Rel. Freq.	Freq.	Rel. Freq.	Freq.	Rel. Freq.	Freq.	Rel. Freq.
ash							10	2
bindweed							30	7
blackberry							20	5
butter and eggs							30	7
clearweed	11	3						
cottonwood	100	29	100	36	100	48	90	21
dogbane							10	2
elm							10	2
horseweed	33	10						
marestail			25	9			60	14
mint							10	2
mulberry							10	2
reed canary grass	78	23	75	27	100	48	100	23
sedge	22	6						
silver maple	11	3					10	2
smartweed	11	3						
sumac	11	3					10	2
thistle							20	5
unknown grass			25	9			10	2
white campion			25	9				
willow	67	19	25	9	10	4		
Average % cover		99		100		100		100


Island 58
Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
ash
cottonwood
elm
horseweed
marestail
mulberry
reed canary grass
sedge
silver maple
smartweed
sumac
thistle
unknown grass
willow
Selected Species
1986
1987
1988
1989

Wabasha Gravel Pit, Pool 4, RM 761.0

The Wabasha Gravel Pit Dredged Material Placement Site (4-761.0-RMP) was an abandoned gravel pit that was partially filled with dredged material when the historic placement site at Reads Landing was first emptied in 1984. It is located in Pool 4 near Wabasha, Minnesota. The filled area consists of about 30 acres of sand 30 to 40 feet deep. The area was seeded in 1985 in an effort to reduce wind erosion. Since that time, the site has been used for subsequent placement of dredged material and the original seeding destroyed.

The area was broadcast seeded in September 1985, and the seed and sand incorporated with a spring-tooth harrow. The following seed mixture and rates were used.

Species	Seeding Rate
switchgrass	3 lbs. PLS/ac.
yellow sweet clover	12 lbs./ac.
alsike clover	6 lbs./ac.
annual rye	10 lbs./ac.

The site was monitored from 1986 through 1990. Total percent cover estimates for the site are shown below (see Figure 6).

Date	Percent Cover
August 1986	15
August 1987	11
August 1988	16
August 1989	12
August 1990	21

Disturbance of the site adversely affected vegetation. The area receives recreational use by all-terrain vehicles (ATVs). Wherever ATVs ran over the site, vegetation cover was reduced to 0%. Recreational and heavy equipment disturbance at other sites such as Lost and Mallard Islands in Weaver Bottoms also set vegetation back to early successional stages. Disturbance includes vehicle and recreational use. Site disturbance seems to cause more impacts on sand sites than on sites covered with fine material. Sites with fine material may recover more quickly; however, weedy species tend to invade the site first.

The percent cover was rather stable over the years. The sandy condition at the site was probably the major factor influencing the relative lack of vegetative cover. Over the monitoring period, the dominant species observed were naturally occurring species such as purple sandgrass, sand dropseed, sedge, switchgrass, carpetweed, brome, clammyweed, winged pigweed, and foxtail. The major conclusion from monitoring at this site was that seeding bare sand will not provide a dense vegetative cover. Based on results of other studies, fine sediment should be incorporated with the sand to form a soil in order to achieve good cover and growth of seeded species.

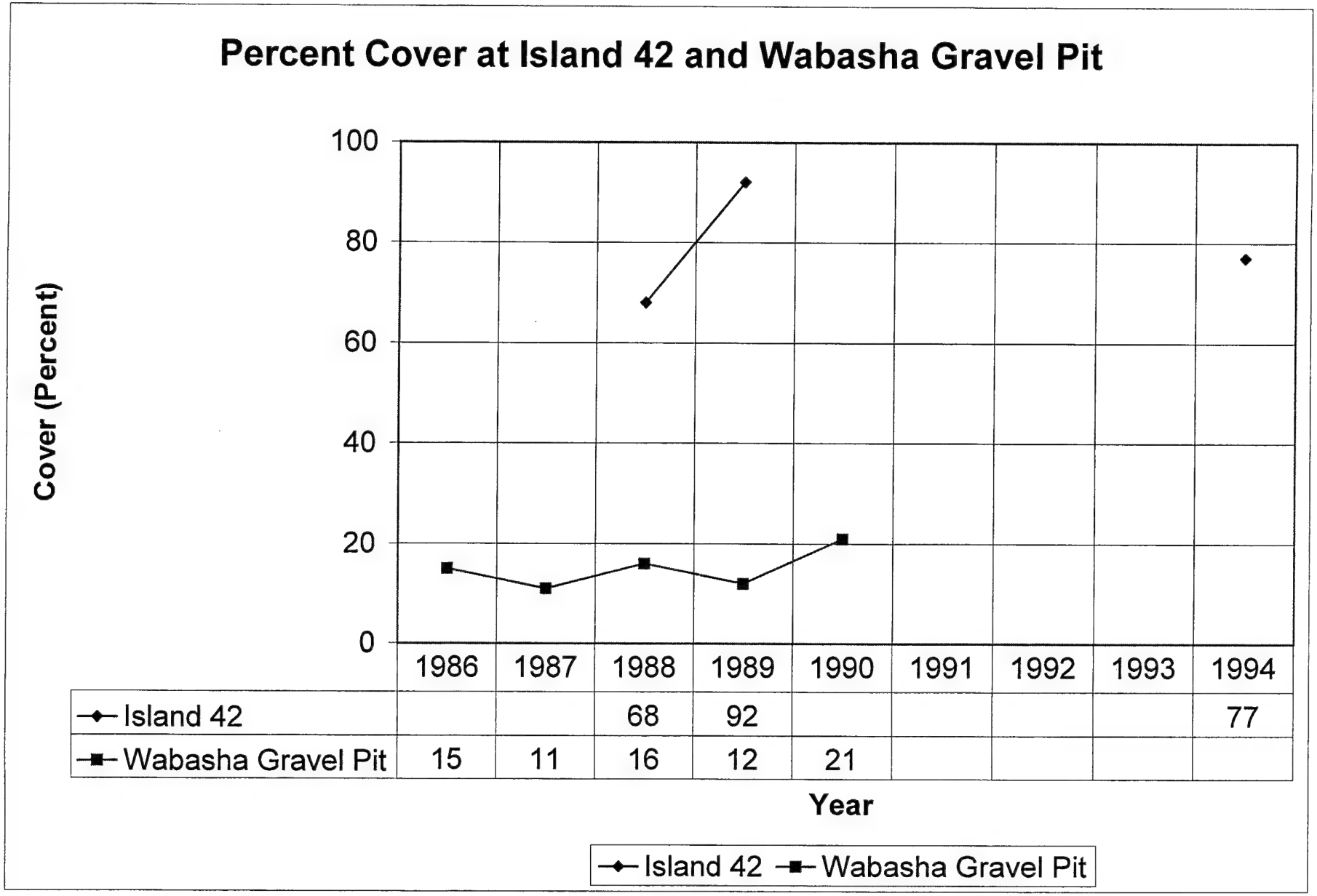
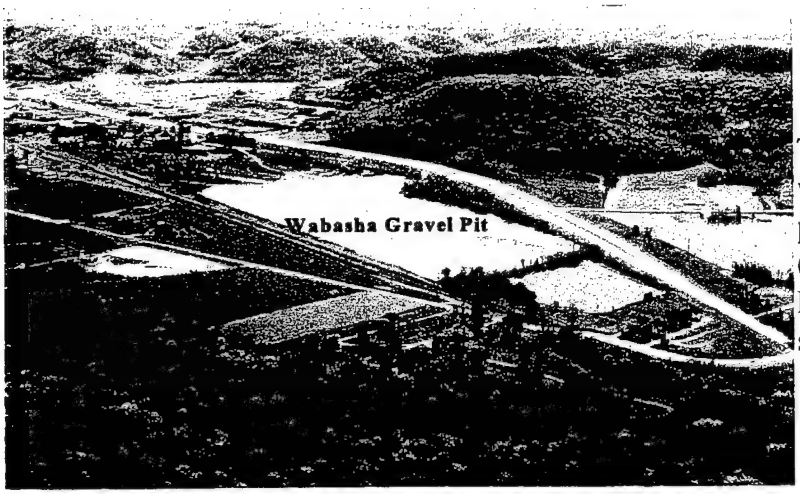


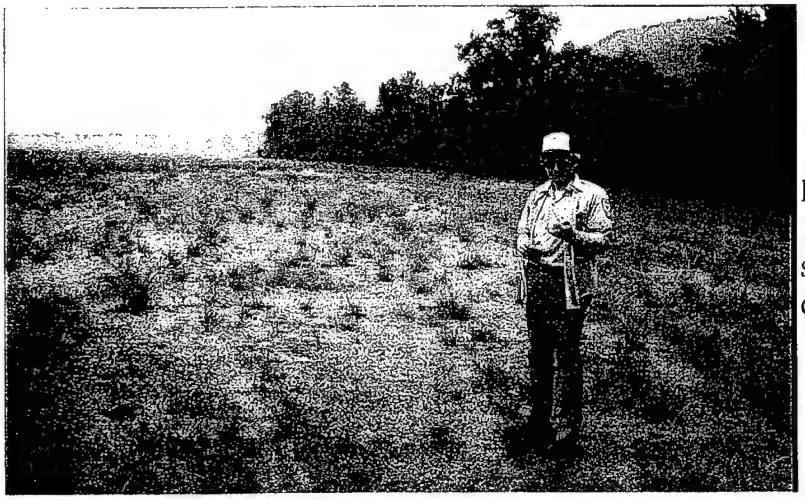
Figure 6. Percent cover estimates for the Island 42 HREP project and Wabasha Gravel Pit.

WABASHA GRAVEL PIT



The Wabasha Gravel Pit in Pool 5 was an abandoned gravel pit that was partially filled with dredged material (sand) from emptying the Reads Landing dredged material placement site.

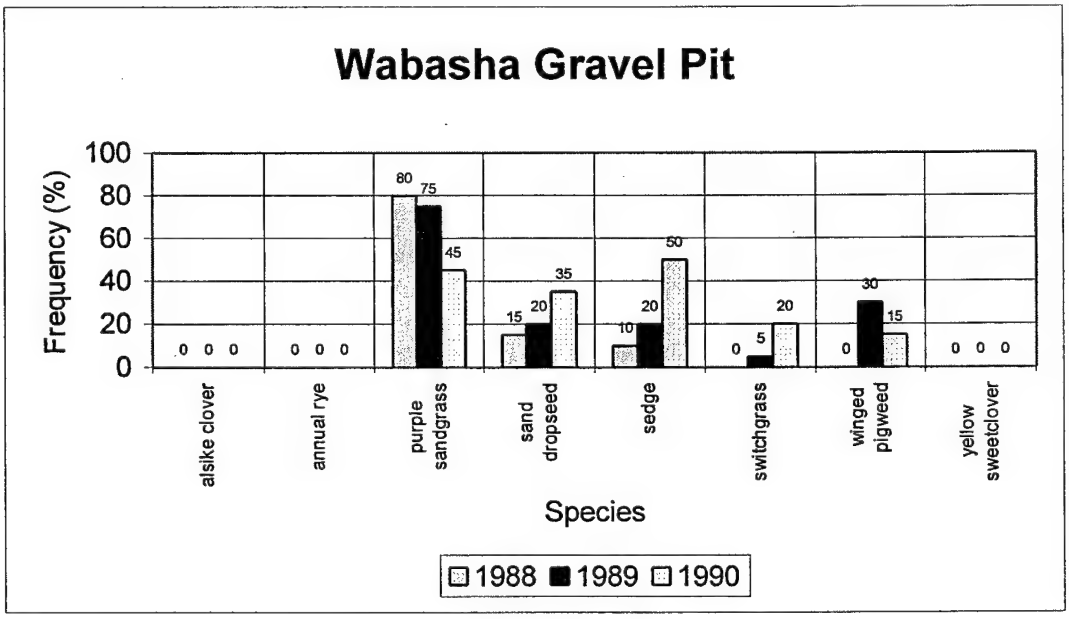
This photo was taken in May 1986, one year after seeding the sand. Topsoil was not applied to the site; percent cover was 15%. Species present included sedge, brome, sand dropseed, and clammyweed.



In August 1987, percent cover was 11%. Dominant species were sedge, switchgrass, purple sandgrass, carpetweed, and brome.

Summary of Plot Data for Wabasha Gravel Pit

	Species * seeded species	YEAR August 1988 Freq.	 Rel. Freq.	 August 1989 Freq.	 Rel. Freq.	 September 1990 Freq.	 Rel. Freq.
	Seeded						
*	alsike clover						
*	annual rye						
	purple sandgrass	80	76	75	50	45	27
	sand dropseed	15	14	20	13	35	21
	sedge	10	10	20	13	50	30
*	switchgrass			5	3	20	12
	winged pigweed			30	20	15	9
*	yellow sweetclover						
	Average % cover	16		12		21	



Minneapolis Park Beaches 1 and 2, Pool 1, RM 849.5 and RM 851.3

Two temporary dredged material placement sites (Below Lake Street Site 1-849.5-RME; Below Franklin Avenue Site 1-851.3-LME) were located in Pool 1 in Minneapolis, Minnesota. They received heavy recreational beach use during the summer. In 1986, the sites were revegetated in an attempt to create more of a park-like setting and to stabilize the sand.

The Below Lake Street Site was drill seeded at the following rate and species:

Species	Seeding Rate
sand dropseed	6 lbs. PLS/ac.
switchgrass	6 lbs. PLS/ac.
blue grama	17 lbs. PLS/ac.
side oats grama	12 lbs. PLS/ac.
little bluestem	4 lbs. PLS/ac.
crown vetch	15 lbs./ac.
Pennfine perennial rye	15 lbs./ac.
Park Kentucky bluegrass	15 lbs./ac.

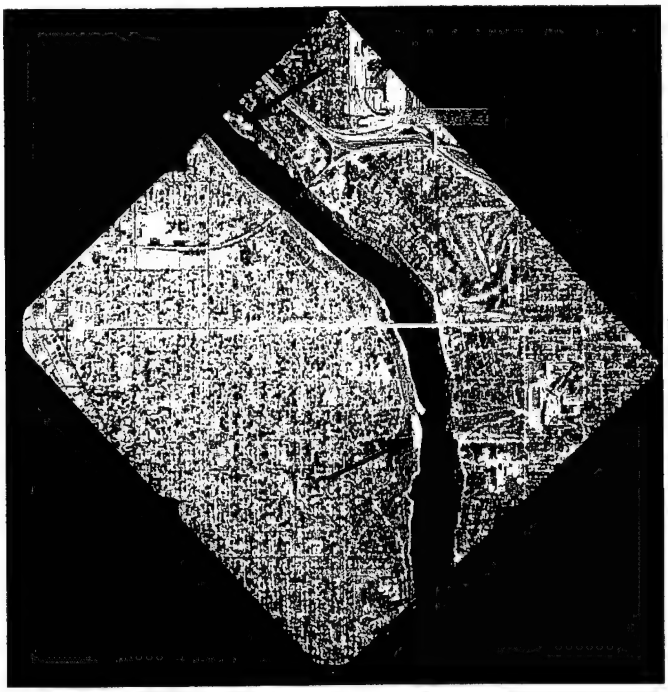
The Below Franklin Avenue Site was drill seeded at the following rate and species:

Species	Seeding Rate
sand dropseed	8 lbs. PLS/ac.
switchgrass	8 lbs. PLS/ac.
blue grama	22 lbs. PLS/ac.
side oats grama	16 lbs. PLS/ac.
little bluestem	6 lbs. PLS/ac.
crown vetch	10 lbs./ac.
Pennfine perennial rye	20 lbs./ac.
Park Kentucky bluegrass	20 lbs./ac.

The areas were seeded in November 1986. Prior to seeding, fertilizer was applied at the rate of 7 pounds per 1,000 square feet and incorporated to a depth of at least 2 inches by disking. The fertilizer was 19-19-19 (N-P-K). After seeding, hay mulch was applied at the rate of 2,000 lbs./acre and anchored using a disk harrow or similar device. Trees were also planted and staked.

Both sites received heavy recreational use during the summer of 1987, and the seeding never had the opportunity to become established. Most of the hay mulch appeared to have been used for beach fires; many of the tree plantings were cut for firewood or vandalized. Some grasses were growing on the sites, but it was impossible to interpret any results from these areas. Monitoring was discontinued.

MINNEAPOLIS PARK BEACHES



Minneapolis Park Beaches in Pool 1. Site 1.07 is at the top arrow and Site 1.03 at the bottom arrow.

The Minneapolis Park Beaches (bare sand) were seeded in 1986. Trees were also planted.

By August 1988, both sites were destroyed by heavy recreational use. The hay mulch and trees were gone (used for beach fires or vandalized) and the original seeding never became established.

Island 42, Pool 5, RM 749.0

Island 42 was the first HREP project constructed in the St. Paul District under the Environmental Management Program. The project was completed in May 1987. Dredged material from channel construction was sidecast along the bank and vegetated by the Minnesota Department of Natural Resources. The placement site was broadcast seeded in June 1987 with rye, bluegrass, brome, timothy, sand dropseed, and birds-foot trefoil at the rate of about 100 lbs./ac.; seed was raked into the dredged material.

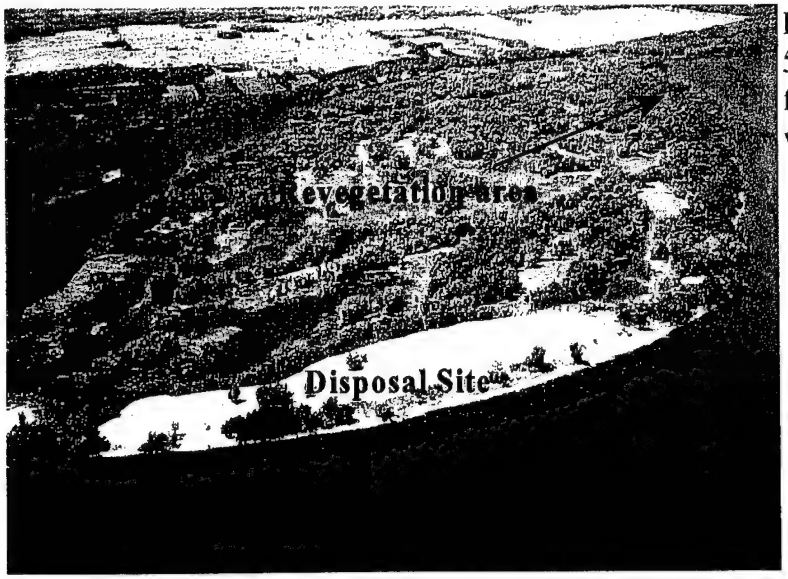
Total percent cover was as follows:

Year	Percent Cover
August 1988	68
August 1989	92
August 1994	77

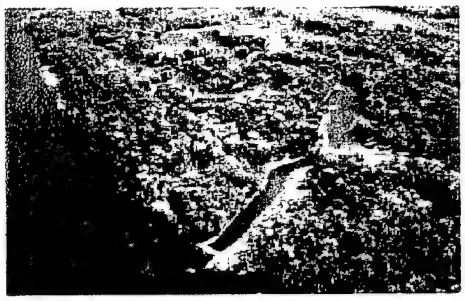
Also see Figure 6. A Robel reading of 2.7 decimeters was recorded in 1994, exceeding the HREP project goal of 1.5 decimeters after 2 years of growth.

The dredged material placement site became well established with vegetation. Dredged material contained some fine sediments which appeared to benefit plant growth; soil analysis in 1994 found 13.5% fine material in the topsoil. Dominant species growing on the site over time were brome and birds-foot trefoil. Switchgrass, sand dropseed, and clover were also present to varying degrees. The seeded area became well established, was dominated by seeded species and sparsity of weeds, and had good overall percent cover.

ISLAND 42



Island 42 HREP project site in Pool 5. The site contained fine sediment from excavating a small channel and was seeded in June 1987.



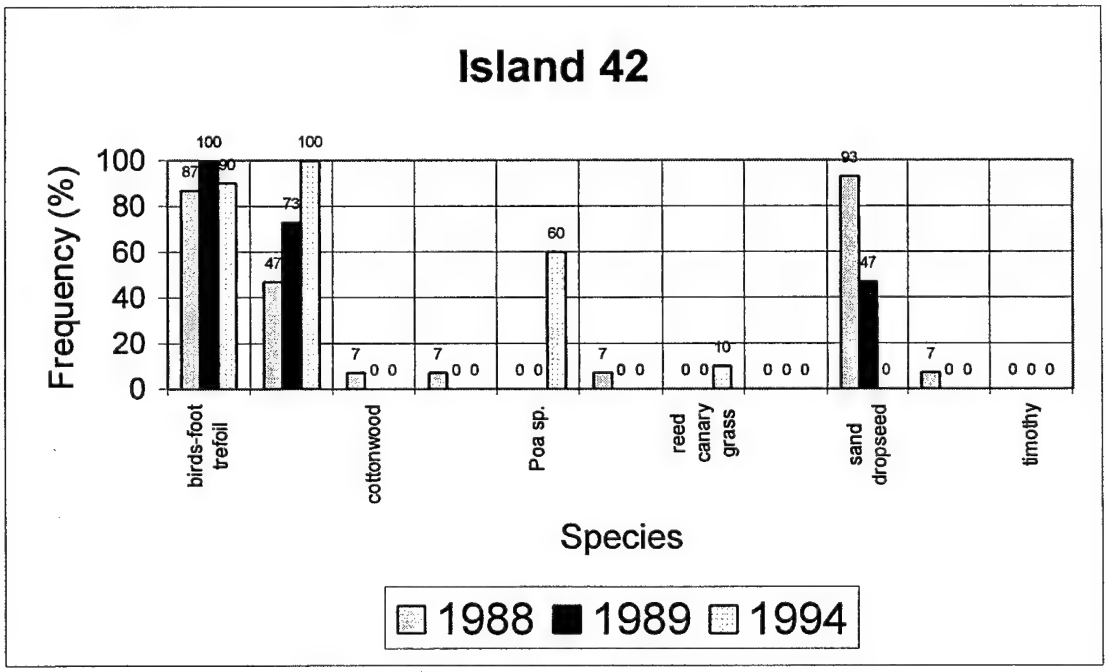
Island 42 HREP project site in Pool 5. Seeded area to right of channel.

In August 1988, sand dropseed was the dominant species with some birds-foot trefoil. Percent cover was 68%.

In 1994, percent cover was 77% with brome, birds-foot trefoil, switchgrass, sand dropseed, and clover covering the site. The Robel reading was 2.7 decimeters.

Summary of Plot Data for Island 42

	Species * seeded species	YEAR Aug-88 Freq.	Aug-89 Freq.	August 1994 Freq.	Rel. Freq.	Dom.	Rel. Dom.	I.V.
*	birds-foot trefoil	87	100	90	35	18	23	29
*	brome	47	73	100	38	50	65	52
	cottonwood	7						
	grass	7						
*	Poa sp.			60	23	9	12	17
	quackgrass	7						
	reed canary grass			10	4	1	1	2
*	rye							
*	sand dropseed	93	47					
	switchgrass	7						
*	timothy							
	Average % cover	68	92	77				
	Robel (decimeters)			2.7				



Weaver Bottoms, Pool 5, RM 742.7 to RM 748.0

Vegetation Measures

Weaver Bottoms is a 5,000-acre backwater in Pool 5 of the Upper Mississippi River. Weaver Bottoms was created by construction of Lock and Dam 5 in 1935. Since inundation, habitat values in Weaver Bottoms have declined, especially aquatic vegetation. In the 1970's, research conducted during the GREAT I study showed that habitat values may be restored by reducing flows and sediments entering Weaver Bottoms from the Upper Mississippi River (side channel closures), and reducing wave action on sediments within the backwater (islands). In 1986, the Lower Pool 5 Channel Maintenance/Weaver Bottoms Rehabilitation Project was the first large-scale backwater restoration project implemented in the St. Paul District. The project had the dual objective of long-term maintenance of the 9-foot navigation channel in lower Pool 5, and creating and maintaining a more diverse riverine habitat for fish and wildlife in Weaver Bottoms.

Two islands (Mallard and Swan) and six side channel closures (MN 10, MN 11, MN 12, MN 13, MN 14, and WI 10B & C) were constructed of sand from past maintenance dredging of the Mississippi River navigation channel. Fine sediment was hydraulically dredged from Weaver Bottoms between Swan and Mallard Islands and placed at selected treatments to enhance vegetation.

A vegetation plan was developed for the Weaver Bottoms Project in 1986 by the Fish and Wildlife Work Group of the Channel Maintenance Forum. The vegetation plan was implemented immediately after construction of the Weaver Bottoms Project to control erosion and provide waterfowl nesting habitat on constructed islands and side channel closures. A variety of plant species and treatments were included in the vegetation project.

Islands

The vegetation plan proposed a variety of treatments involving the placement of fine sediment and plantings. Individual cells were constructed on the islands and alternately filled with fine dredged material and allowed to dry before spreading. Both Swan and Mallard Islands were covered with about 6 inches of fine dredged material. However, in actual practice, it was not possible to distribute the fine sediment evenly on the islands, and in some areas, it was over 12 inches thick. Attempts were made to incorporate fine sediments with the sand substrate using a disk or bulldozer, as recommended in the original vegetation plan. However, due to the thickness of the fine material in certain areas, disking was unable to adequately mix the fine material with the sand, and it did not establish a uniform silt/sand topsoil over the entire island surface, as originally intended.

Mallard Island was used as a control and was not seeded. Swan Island was drill seeded by June 15, 1988. The side slopes of both islands were mulched with 1 ton per acre of hay and anchored using a disk.

Swan Island was divided into "dry" and "wet" seeding zones on the basis of soil moisture, as recommended in the original vegetation plan. The following seed mixture was drill seeded in the dry zone above elevation 663 on Swan Island. PLS designates Pure Live Seed.

Species	Seeding Rate
Indian grass	4 lbs. PLS/ac.
switchgrass	2 lbs. PLS/ac.
little bluestem	3 lbs. PLS/ac.
sand reedgrass	1 lb. PLS/ac.
sand dropseed	1 lb. PLS/ac.
side oats grama	1 lb. PLS/ac.
Canada wild rye	1 lb. PLS/ac.

The following seed mixture was drill seeded in the wet zone below elevation 663 on Swan Island.

Species	Seeding Rate
prairie cordgrass	5 lbs. PLS/ac.
Canada wild rye	4 lbs. PLS/ac.
big bluestem	2 lbs. PLS/ac.
switchgrass	2 lbs. PLS/ac.
Indian grass	2 lbs. PLS/ac.

The Winona, Minnesota, Office of the U.S. Fish and Wildlife Service burned Swan Island on April 3, 1991, as part of its habitat management activities. The top central portion of the island was the only place where there was sufficient vegetative "fuel" for the fire to burn (burned area). Vegetation on the remainder of the top and sides of the island was not sufficient to carry the fire; this area was referred to as unburned.

As an additional erosion control treatment, willow, dogwood, and false indigo cuttings were planted on Swan Island at selected locations in April 1991.

At various times over the years, other treatments such as the placement of rock groins, planting aquatic vegetation, and bio-engineering practices were undertaken to help reduce shoreline erosion around the islands. The effects of these activities are not summarized here, although the rock groins appear to have been the most effective. Willow plantings have also been effective for shoreline stabilization.

In 1991, Swan Island was burned, and vegetation sampling was conducted on burned and unburned areas that year only. In 1992, the Wisconsin closures were combined into one sampling unit because they received the same planting treatment and resulting vegetation was similar.

In April 1994, the U.S. Fish and Wildlife Service conducted the following seeding and planting on Swan and Mallard Islands as part of its management activities.

Mallard Island

hoary vervain	5 oz. broadcast on top of the island
round headed bush clover	5 oz. broadcast on top of the island
Indian grass	6 oz. broadcast on top of the island
switchgrass	8 oz. broadcast on top of the island
panicled (gray) dogwood	2 lbs. (1992 seed) broadcast on top of the island
sand cherry	1 lb. (1992 seed) broadcast on top of the island
wild grape	1 lb. broadcast on top of the island
buttonbush	4 lbs. along the shoreline only; part of this was put on Swan Island
willow	several hundred stems along the shoreline

Swan Island

buttonbush	1 to 2 lbs. spread along the shoreline where willows were planted
wild indigo	seeds harvested on the island and broadcast with buttonbush seed. These seeds were covered by sand by stepping along the shoreline.
willow	several hundred stems along the shoreline

Soil samples were taken on Mallard and Swan Islands in September 1994 to determine the percent of fine material remaining at the sites and to test for a relationship with vegetation density. Soil samples were collected by hand with a soil probe to a depth of approximately 12 inches. The results of the soil analysis are presented in the Appendix.

Erosion and bank sloughing have occurred along the shoreline of the islands as they naturally stabilize. Hybrid willow, native willow, dogwood, and false indigo cuttings were planted at various locations on Swan Island in April 1991 to test survival and effectiveness in controlling erosion. The hybrid willow (*Salix alba "Calva"* and *Salix alba "Nova"*) were obtained from the Natural Resources Research Institute in Duluth, Minnesota, while the native willow, dogwood, and false indigo were cut in Pools 5 and 8.

Side Channel Closures

Six side channel closures were evaluated in the vegetation study: four located in Minnesota (MN) and two in Wisconsin (WI). Closure MN 14 consisted of an unvegetated rock closure and was not part of the monitoring activities, and the Wisconsin closures were combined in 1992. Side channel closures were seeded in July 1988. As recommended in the vegetation plan, placement of fine sediment and seeding were not conducted on side slopes adjacent to the main navigation channel to avoid recreation conflicts.

MN 10 - Control site. No fine sediment was placed on this closure, and no seeding was conducted.

MN 11 - Fine sediment was placed on the west side slope and on the top of the closure and incorporated with the sand using a disk. Prairie cordgrass was drill seeded in the wet zone below elevation 663 at the rate of 10 lbs. PLS/acre. In the dry zone above elevation 663 and on the top of the closure, the following seed mixture was drill seeded. Mulch was applied to the side slope of the closure at the rate of 1 ton per acre and anchored.

Species	Seeding Rate
little bluestem	4 lbs. PLS/ac.
side oats grama	4 lbs. PLS/ac.
switchgrass	4 lbs. PLS/ac.

MN 12 - No fine material was placed on this closure. Three rows of American beachgrass stolons were planted in the wet zone below elevation 663 on the west side slope. Sand dropseed was drill seeded on the rest of the side slope and on the top of the closure at the rate of 18 lbs. PLS/acre. Mulch was applied to the side slope at the rate of 1 ton per acre and anchored.

MN 13 - Fine material was placed on this closure and incorporated with the sand using a disk. Three rows of rice cutgrass stolons were planted in the wet zone below elevation 663 on the west side slope. The following seed mixture was drill seeded on the side slope and on the top of the closure. Mulch was applied at the rate of 1 ton per acre and anchored.

Species	Seeding Rate
thickspike wheatgrass	6 lbs. PLS/ac.
green needlegrass	5 lbs. PLS/ac.
Canada wild rye	5 lbs. PLS/ac.

WI 10 B and 10 C - Fine material was placed on each of these ½-acre closures and incorporated into the sand using a disk. The following seed mixture, plus any seed material remaining from the rest of the project, was broadcast seeded evenly on the two closures. Consequently, the exact species composition of the seed mixture is not known. No mulch was applied.

Species	Seeding Rate
prairie dropseed	13 lbs. PLS/ac.
big bluestem	10 lbs. PLS/ac.
side oats grama	5 lbs. PLS/ac.
Indian grass	10 lbs. PLS/ac.
showy sunflower	10 oz./ac.
rough blazing star	20 oz./ac.
black-eyed Susan	10 oz./ac.

Monitoring Results

Vegetation monitoring has been conducted since 1988 when the sites were prepared and seeded. Monitoring was usually conducted in mid-August. Plot data was not obtained in 1990. The

percent cover for that year is based on an ocular estimate and should be considered when comparing to other years. Since 1990, the wet zone of the side slopes of the islands and the closures were eliminated from the sampling program. Because of erosion, these areas no longer constituted a large portion of the treatment site, and the vegetation present was greatly influenced by flood events.

The results of the vegetation monitoring activities are summarized below for each treatment.

Swan Island

In 1988, the year of establishment, the most frequently observed species on Swan Island were side oats grama and wild oats. Wild oats was probably present in the mulch and provided a good nurse crop that year. By 1989, wild oats had disappeared, and the most frequent species were side oats grama, Canada wild rye, pigweed, and winged pigweed.

In 1991, the first year that both frequency and dominance data were collected, the most important species (based on importance value) on Swan Island were side oats grama, switchgrass, Canada wild rye, and alfalfa. All of these species were seeded except for alfalfa. The four most important species found on Swan Island in 1995 were switchgrass, side oats grama, ragweed, and clammyweed. Side oats grama and switchgrass have always been dominant species on Swan Island. Weedy species also continue to occupy a small percent of the island.

All species seeded on Swan Island have been observed over the study. Prairie cordgrass and big bluestem were present on Swan Island but were not found on any survey plots. These species were found mostly near the shoreline at random locations and are not very common.

The Jaccard Index of Similarity shows that Swan and Mallard Islands have about 25% of their species in common. This index has remained fairly constant over the last few years.

Percent cover estimates have been taken since the project was constructed. Percent cover for 1990 was based on ocular estimates only; no individual plot data were taken that year. The table below summarizes the results of the monitoring.

	Percent Cover (date)						
Site	8/1988	8/1989	9/1990	9/1991	8/1992	9/1993	8/1995
Swan Island							
Overall	4	54	100	66	59	77	51
Burned				86			
Unburned				47			

Percent cover results for Swan and Mallard Islands are shown on Figure 7.

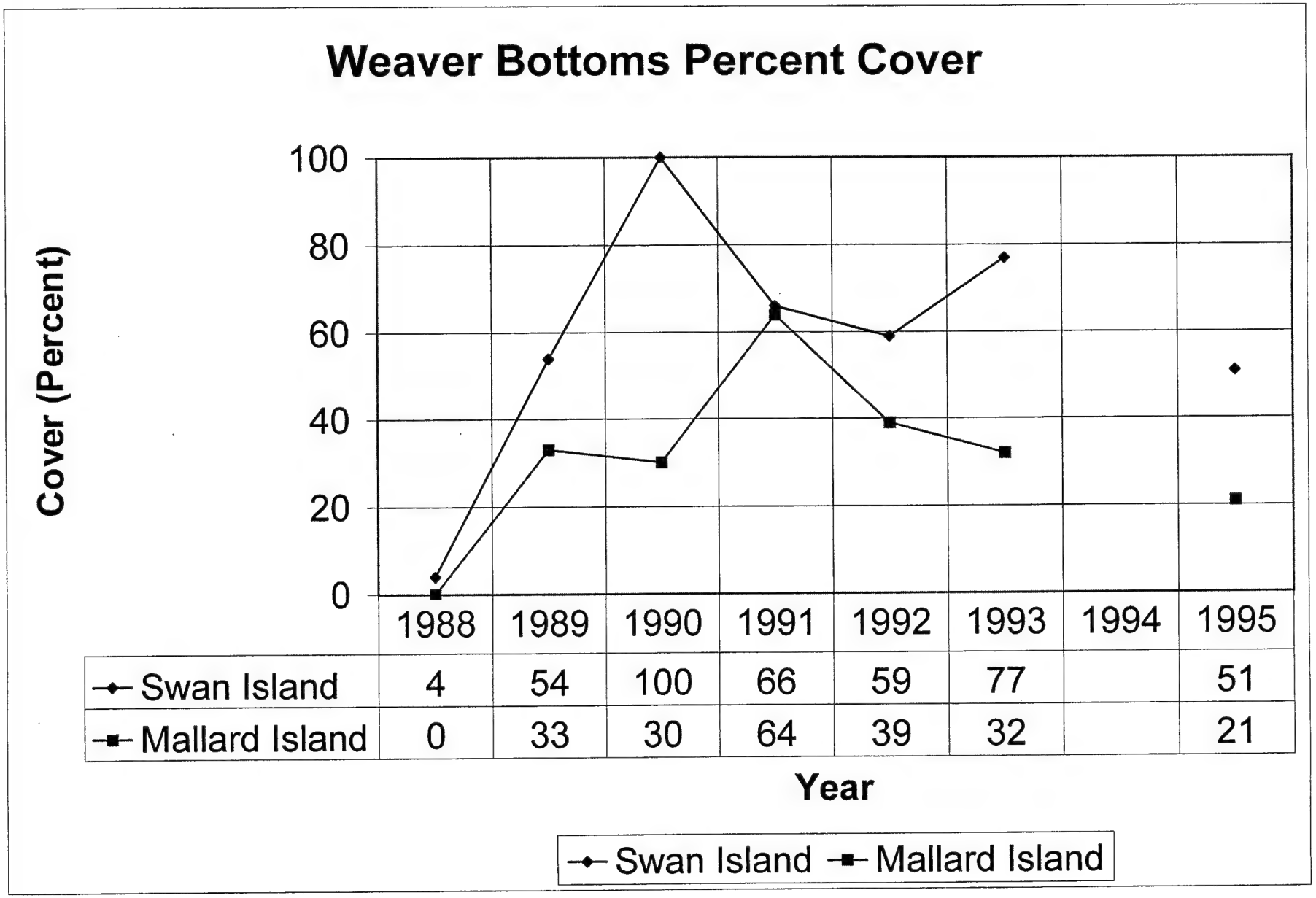


Figure 7. Percent cover estimates for Mallard and Swan Islands at Weaver Bottoms.

Since 1989, the density of vegetation on Swan Island has been quite high (51% to 100%) and dominated by grasses. Except for 1991, the Analysis of Variance (ANOVA) found a significant difference in percent cover between the seeded Swan Island and the unseeded Mallard Island. Percent cover has been variable over time and was 51% in 1995.

The burning of Swan Island in the spring of 1991 temporarily enhanced the growth of vegetation. There was a significant difference in the percent cover between the burned and unburned portions of the island. By 1992, there was no visible difference in vegetation between burned and unburned areas, and monitoring of these treatments ceased.

The Jaccard Index of Species Similarity for the burned and unburned areas in August 1991 was 71, indicating that the burn had little effect on species composition. However, it did have an effect on both total abundance and abundance of individual species. On the basis of importance values, the dominant species on Swan Island were as follows:

	Swan Island		
Year	Burned	Unburned	Combined
1991	Canada wild rye switchgrass side oats grama	side oats grama alfalfa switchgrass	
1992			side oats grama Canada wild rye switchgrass
1993			clover switchgrass side oats grama
1995			switchgrass side oats grama clammyweed & ragweed

Monitoring showed that dogwood will sprout from cuttings with about 44% success. False indigo also sprouted from cuttings at a success rate of approximately 50%; however, the root system was not very well developed.

The willow test results were variable. Hybrid willow usually had a higher sprouting percentage than native willow, about 80% and 60%, respectively. Also, the hybrid willow appeared to have a more developed root system. However, the native willow are also growing and have developed a root system. It appears that native willow will accomplish the desired results.

Since 1992, it has been difficult to distinguish growth and abundance of willow between cuttings and natural reproduction in some areas. Sediment resulting from erosion of the side slopes has buried some of the original cuttings. Willow shoots are present and growing, however. False indigo and native and hybrid willow are all growing, but some of this could be natural reproduction. In areas less affected by sediment, the original cuttings could still be seen and represented about 40% survival in 1993. The cuttings were not evaluated in detail in 1995. However, willow growth is dense in the areas of the plantings. As in 1993, natural and planted growth was difficult to differentiate due to erosion and sedimentation.

Survival of cuttings is higher and the results are more effective in areas that are subject to little erosion or sedimentation. In areas subject to erosion, cuttings may have to be used in conjunction with other bio-engineering or engineering methods to control the erosion.

Mallard Island

Mallard Island was not seeded and was used as the control. It was assumed that there would be an abundant seed bank in the fine sediment used for topsoil and that vegetation would become established quickly. However, vegetation has been relatively sparse and dominated primarily by weedy species such as winged pigweed and marestail. The source of the fine material was an area between Swan and Mallard Islands. A hole about 15 feet deep was created to dredge the fine material. Some reasons for the poor establishment could be that the dredged material was very old or material was dredged from too great a depth, resulting in few viable seeds.

In 1989, winged pigweed was the most frequent species and exhibited exceptional growth. It declined in later years. In 1991, alfalfa, marestail, and sand dropseed became more important as reflected by importance values. The most important species in 1993 were clover, marestail, and sand dropseed. In 1995, the dominant species were clover, sand dropseed, and marestail.

Mallard Island was not seeded or burned. The vegetation, in contrast to Swan Island, was quite weedy and not as dense. The Robel readings for 1993 and 1995 were 0.6 and 0.5 decimeter, respectively, compared to readings of 3.1 and 3.5 decimeters, respectively, for Swan Island. Figure 8 shows the results of the Robel monitoring on Swan and Mallard Islands.

Percent cover estimates for Mallard Island are presented below and on Figure 7.

	Percent Cover (date)						
Site	8/1988	8/1989	9/1990	9/1991	8/1992	9/1993	8/1995
Mallard Island	0.0	33	30	64	39	32	21

With the exception of 1991, percent cover was significantly lower on Mallard Island than on Swan Island. The significant decrease in percent cover between 1991 and 1992 was due to the decline of marestail and alfalfa. While it appears that the percent cover of grasses and herbs is slowly increasing over time on Swan Island, weedy vegetation is still common and varies in importance from year to year. Species similarity between Swan and Mallard Islands is approximately 25%.

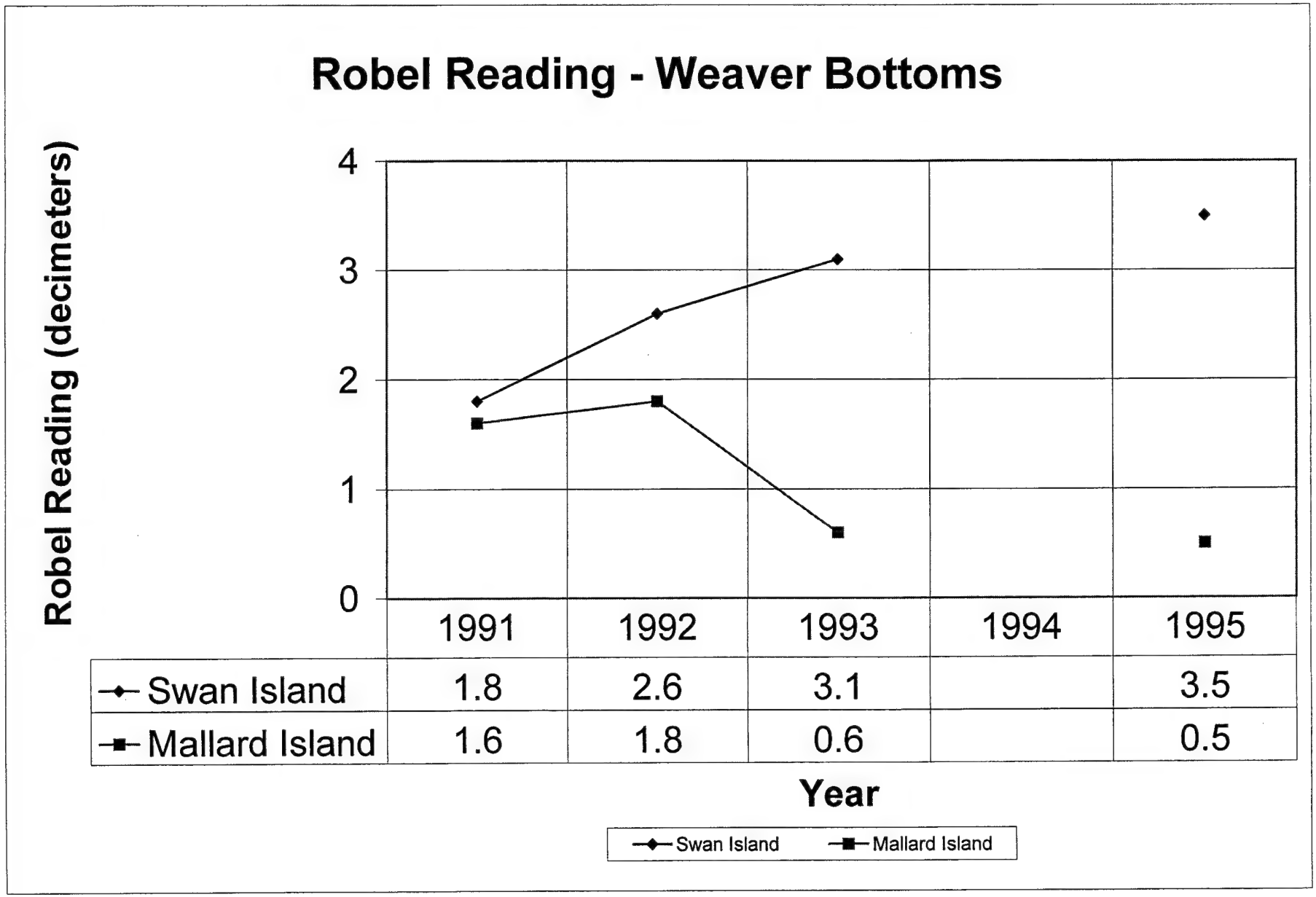


Figure 8. Robel readings for Mallard and Swan Islands at Weaver Bottoms.

On the basis of importance values, the dominant species on Mallard Island were as follows:

1991	1992	1993	1995
marestail	white sweetclover	clover	clover
alfalfa	sand dropseed	marestail	sand dropseed
sand dropseed	unknown grass	sand dropseed	marestail

Side Channel Closures

Side channel closures received a variety of treatments including no treatment (control), seeding bare sand, sprig planting, and topsoil with seeding. As would be expected, a variety of results was found.

Site MN 10 was the control treatment. The species composition has not changed much over time. The most common species continue to be winged pigweed, jointweed, purple sandgrass, and sand dropseed. Most of these species are weedy annuals with a low percent cover. In 1995, total percent cover was 12%.

Site MN 11 was capped with fine sediment and seeded. Side oats grama, alfalfa, and switchgrass are the most common species. Seeded species have always dominated the site. There continues to be a good percent cover of desirable grass species. In 1995, total percent cover was 64%.

Site MN 12 was seeded with sand dropseed on bare sand (no fine sediment added). Winged pigweed and sand dropseed are the dominant species but with a low overall percent cover. Sand dropseed is also a natural invader on sand sites on the river. Total percent cover in 1995 was 13% on the seeded area.

American beachgrass stolons were planted along the shore on the Weaver Bottoms side. Many of the original beachgrass stolons did not survive the summer flood of 1993. The plants that did survive are expanding vegetatively and cover a larger area each year.

Site MN 13 was also covered with fine sediment and seeded. Over the years, a variety of species have been observed. Dominant species include Canada wild rye, sand dropseed, marestail, and alfalfa. Rice cutgrass is found along the shoreline in very small quantities; it was not found in any sample plots. Rice cutgrass occurs naturally on the river. Because of its limited abundance on Site MN 13, it is not known if the presence of rice cutgrass is a result of the original plantings. In 1995, total percent cover for Site MN 13 was 24%.

The Wisconsin closures (Site WI 10) also received fine material and were seeded. Vegetation is growing well and is dominated by grasses and the flowering herbs that were seeded, particularly black-eyed Susan. Total percent cover in 1995 was 44%.

Height/Density Relationships

Robel pole readings in 1995 on the side channel closures varied among sites. The highest reading was on the Wisconsin closures at 1.4 decimeters, which was an increase of 0.4 decimeter since 1993. MN 10 and 12, which did not receive any fine material, had Robel readings of 0 and 0.1 decimeter, respectively. There were major decreases in the Robel readings on MN 11 and MN 13 in 1995.

Percent Cover and Species Variation Among Treatments

Percent cover estimates were calculated for all of the closures. Results of the monitoring are summarized below and on Figure 9.

	Percent Cover (date)						
Site	8/1988	8/1989	9/1990	9/1991	8/1992	9/1993	8/1995
MN 10	13	13	10	24	11	12	12
MN 11	1	51	65	56	62	69	64
MN 12	2	15	5	17	13	18	13
MN 13	1	39	50	37	40	65	24
WI 10	1	56	40		48	61	44

Results of the ANOVA test show significant differences in percent cover among all but one of the sites that received fine material and those that did not. Sites that received fine material as topsoil tended to have higher vegetation densities. There were no significant differences in percent cover between 1991 and 1992 on any of the Minnesota closures. There was a significant difference in the percent cover between 1992 and 1993 on MN 13.

See Figures 9 and 10 for a graphical presentation of the results of the percent cover and Robel monitoring of the side channel closures.

The Jaccard Index of Similarity indicated that none of the sites have many species in common. The index was usually less than 25. The notable exceptions are Sites MN 10 and MN 12, which are essentially identical in species composition. In later years, the index for MN 10 and MN 12 was 70 or greater. Neither of these sites received any fine material.

Areas where beachgrass was originally planted on MN 12 expanded in size through 1992. At that time, there were three distinct areas of beachgrass. One area on the south end of the closure was about 48 feet by 6 feet, a central portion about 54 feet by 20 feet, and one on the north end of the closure about 36 feet by 15 feet. The summer flood in 1993 severely affected the abundance of beachgrass, and only one area of plants survived. Mortality of plants in other areas appeared to be related to flooding and debris accumulation. In 1995, the remaining small area of beachgrass had expanded vegetatively by its roots into higher and less flood prone portions of the site. This area of beachgrass should continue to expand vegetatively in the absence of similar flooding in the future.

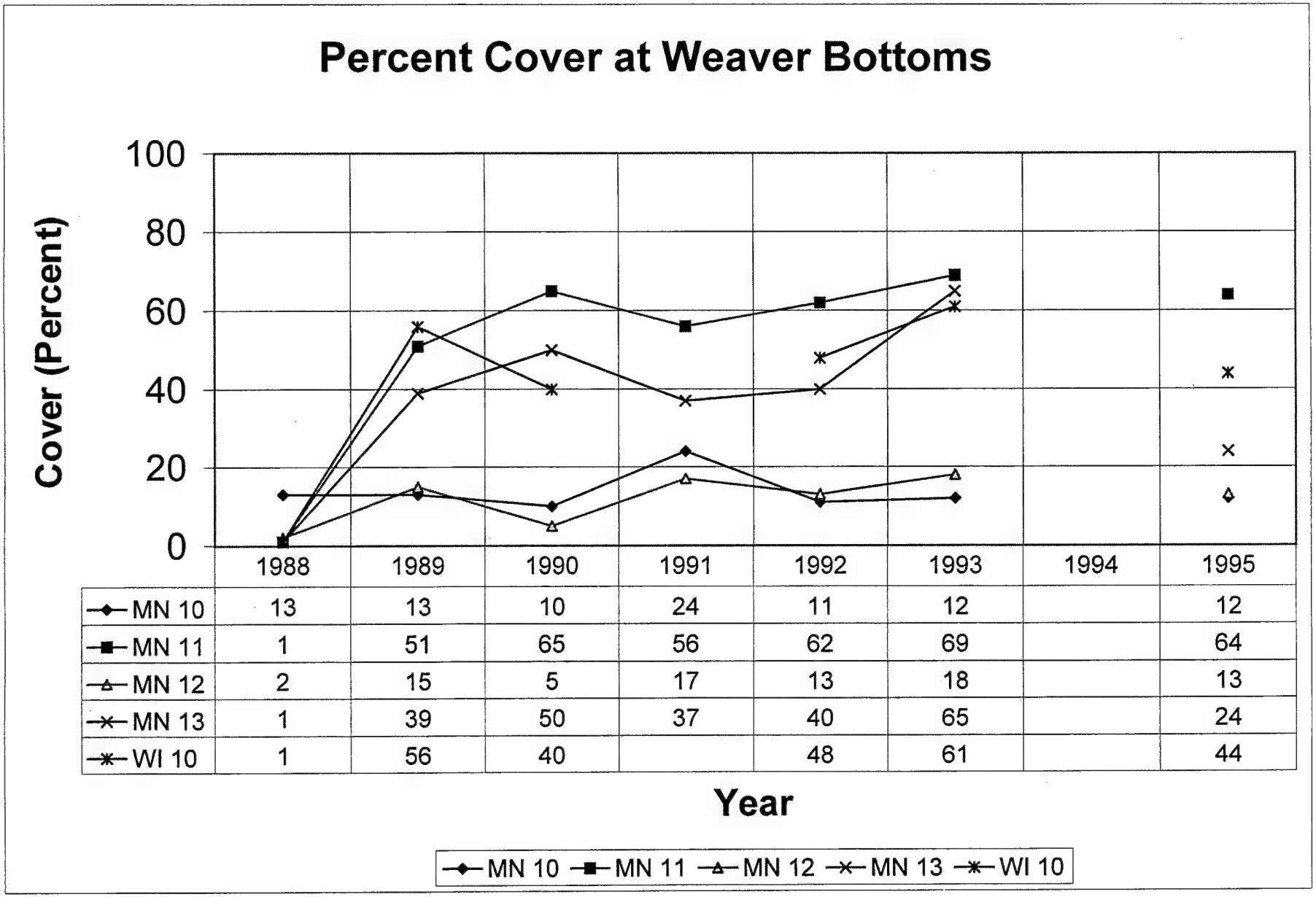
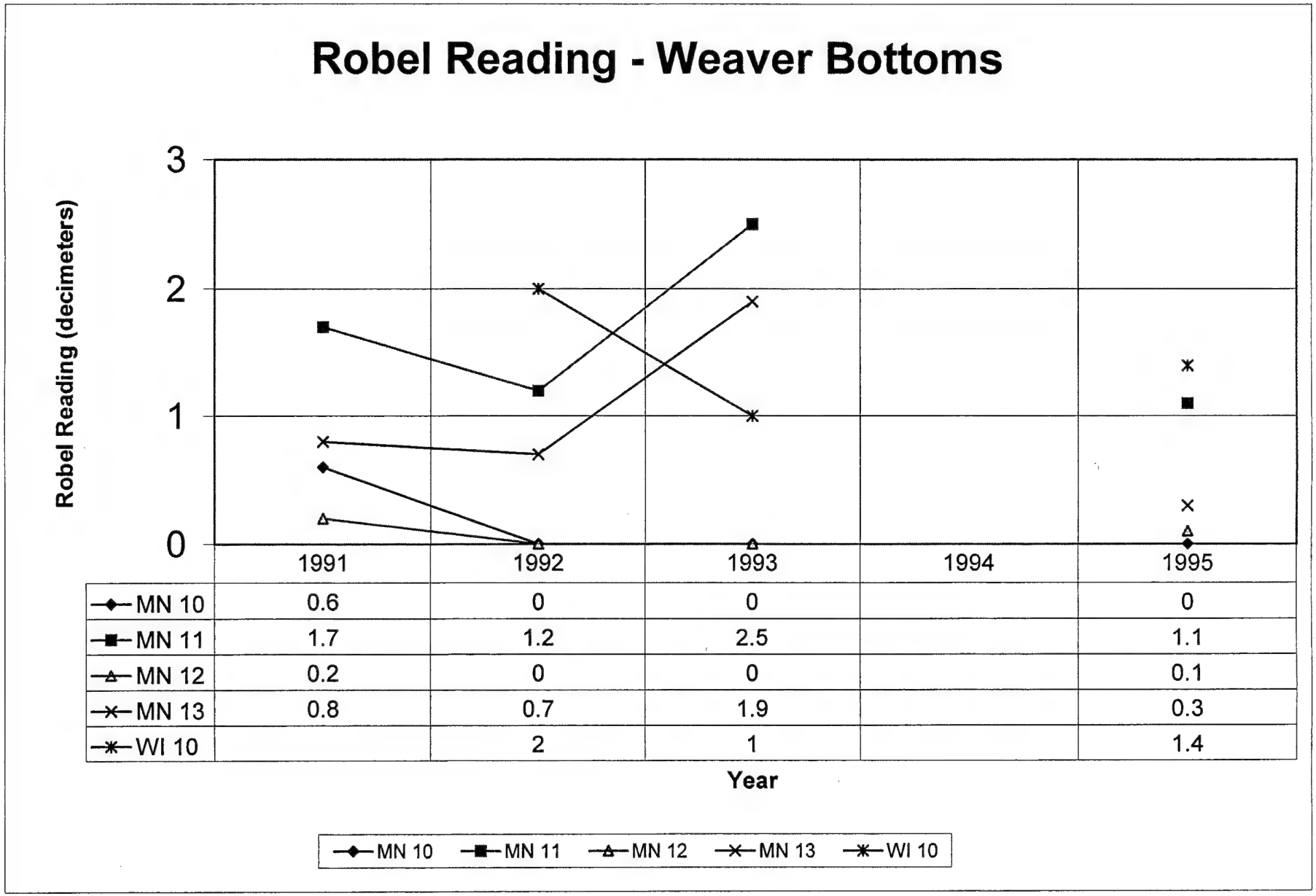


Figure 9. Percent cover estimates for the Weaver Bottoms side channel closures.



	1991	1992	1993	1994	1995
MN 10	0.6	0	0		0
MN 11	1.7	1.2	2.5		1.1
MN 12	0.2	0	0		0.1
MN 13	0.8	0.7	1.9		0.3
WI 10		2	1		1.4

Figure 10. Robel readings for the Weaver Bottoms side channel closures.

The most important species, on the basis of importance value, found on each of the closures are indicated below.

	YEAR			
Site	1991	1992	1993	1995
MN 10	sand dropseed jointweed purple sandgrass	jointweed purple sandgrass sand dropseed	jointweed purple sandgrass sand dropseed	sand dropseed purple sandgrass wormwood
MN 11	side oats grama alfalfa switchgrass	side oats grama white sweetclover switchgrass	clover switchgrass side oats grama	side oats grama switchgrass lambsquarters
MN 12	winged pigweed sand dropseed clammyweed & purple sandgrass	sand dropseed jointweed winged pigweed	sand dropseed jointweed purple sandgrass	sand dropseed purple sandgrass sedge
MN 13	Canada wild rye alfalfa sand dropseed	sand dropseed wheatgrass wormwood	clover unknown grass wormwood	wormwood unknown grass sand dropseed
WI 10		side oats grama black-eyed Susan white sweetclover	big bluestem witchgrass Indian grass	Canada wild rye side oats grama clover & big bluestem

The seeded closures that received fine material generally have more grasses and desirable vegetation. Sand closures MN 10 and MN 12 have more weedy species and lower percent cover.

Summary

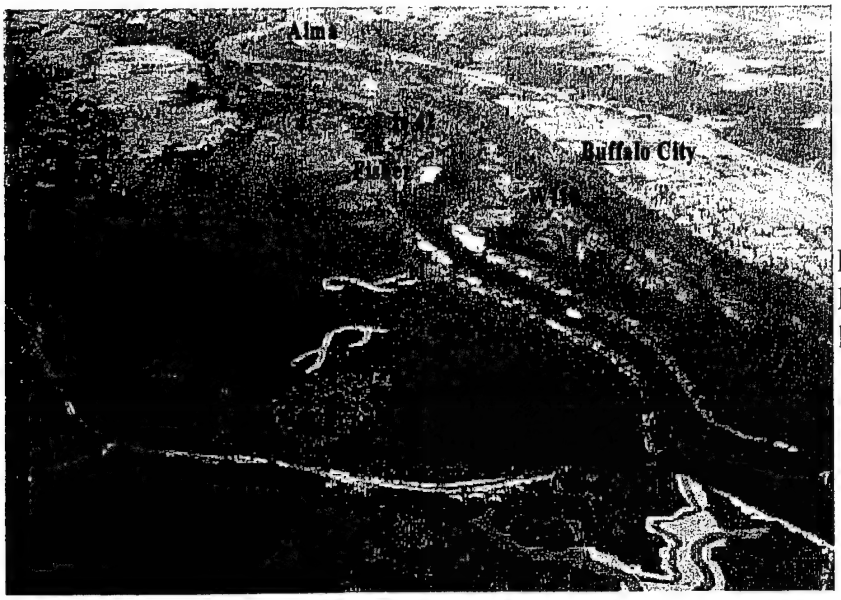
Construction of the islands and side channel closures in Weaver Bottoms was completed in June and July of 1988. A variety of vegetation treatments were implemented for erosion control, habitat creation, and aesthetic purposes. Treatments involving seeding and placement of fine sediment exhibited the most consistent species composition and the highest percent cover. Total percent cover varied from 12% on unseeded treatments without fine sediment to 62% on seeded areas with fine sediment. Canada wild rye, side oats grama, switchgrass, and sand dropseed established quickly on treatments with fine sediment.

Different treatments exhibited a wide range of results. However, several observations can be made. Sites such as Swan Island that were covered with fine sediment and seeded tended to have higher plant density, higher Robel pole readings (height/density relationship), and fewer weedy species. Vegetation on all of the sites that received fine material continued to grow well in 1995. With the exception of MN 13, the sites have a good density of desirable species.

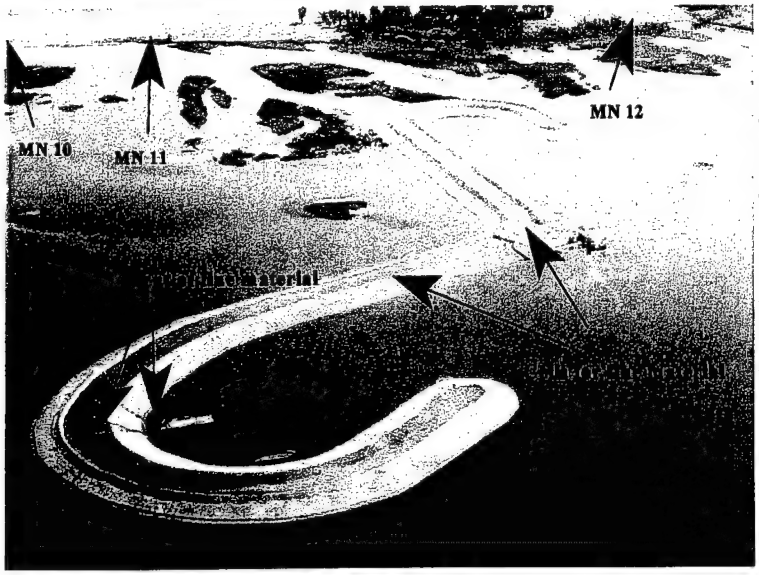
Mallard Island received fine sediments but was not seeded. Vegetation on this site is less dense and is predominantly weedy species in comparison to Swan Island which received topsoil and was seeded. Sites that did not receive any fine material also have lower densities of vegetation and are generally dominated by weedy species. It will undoubtedly be many years, if ever, before these sites revegetate to any degree of similarity to sites that received topsoil and were seeded.

Burning Swan Island in 1991 temporarily increased the density of vegetation. However, one burn seemed to have little long-term effect on vegetation at the site. A management plan consisting of periodic burning may result in different conclusions. Soil samples were taken on the islands in September 1994 to determine the percent of fine material present and to test for a correlation with the vegetation abundance. Mallard and Swan Islands, both of which had topsoil applied, had about 30% fine material in the surface 10 inches in 1994. Because both islands had about 30% fine material, no conclusions can be made regarding vegetation density and percent surface fine material. The primary difference between these sites with respect to vegetation appeared to be that Swan Island was seeded.

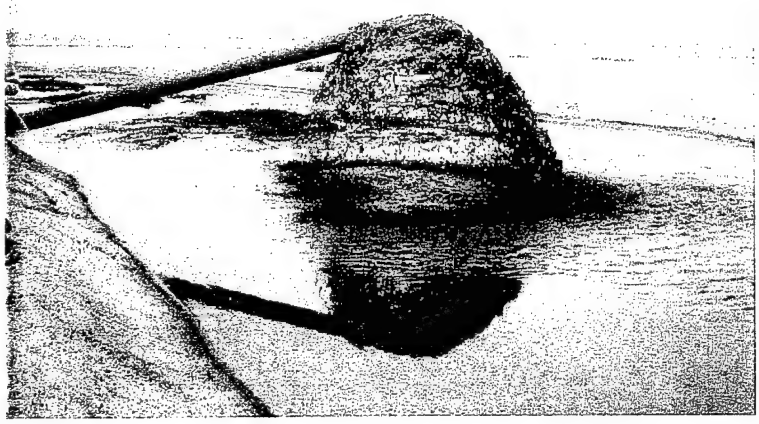
WEAVER BOTTOMS



Lower Pool 5 Channel Maintenance/Weaver Bottoms Rehabilitation Project in Pool 5.

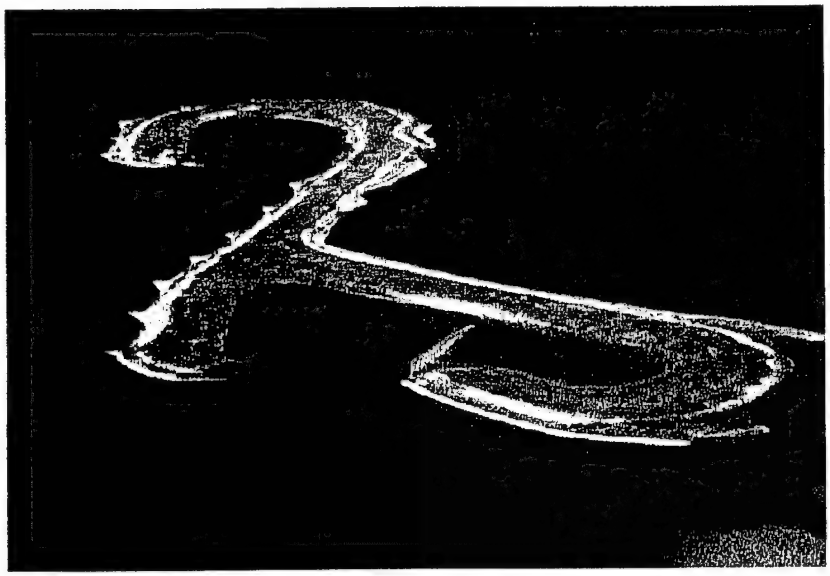


Mallard and Swan Islands were constructed in 1987. Fine dredged sediment was placed into cells constructed on top of the islands and allowed to dry before spreading. The containment cell at the top of this photo of Mallard Island is empty and fine material is being pumped into the bottom cell. Side-channel closures MN 10, 11, and 12 can be seen at the top of the photo.



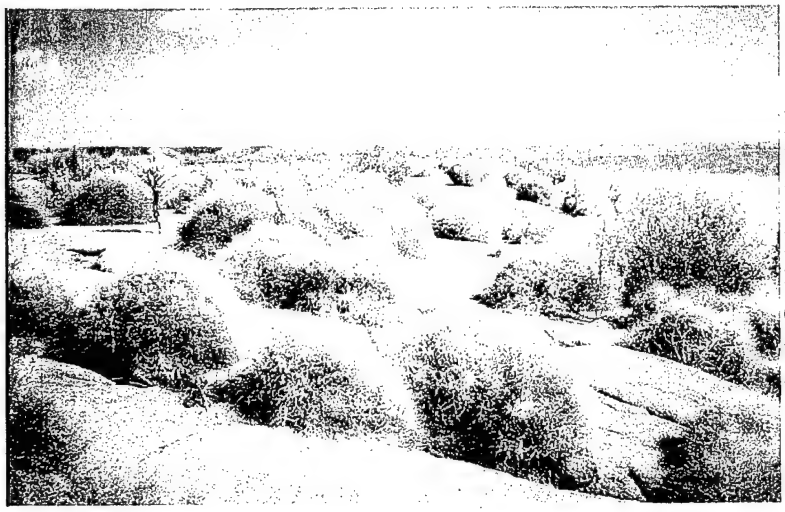
Pumping fine material into the cells on the top of Mallard Island in August 1987. Fine sediment was placed on both Mallard and Swan Islands. When the cells were filled, sediments were left to dry. Dried material on both islands was spread with a bulldozer in 1988.

WEAVER BOTTOMS



Mallard Island was capped with fine material but not seeded. The fine material was obtained from an area to the left of the island, creating a 14-foot-deep hole for fishery habitat. Rock groins and various bioengineering techniques were used to help stabilize the shoreline.

Mallard Island as it appeared in August 1988. Fine material was graded about 2 weeks prior to this photo. Percent cover was zero.

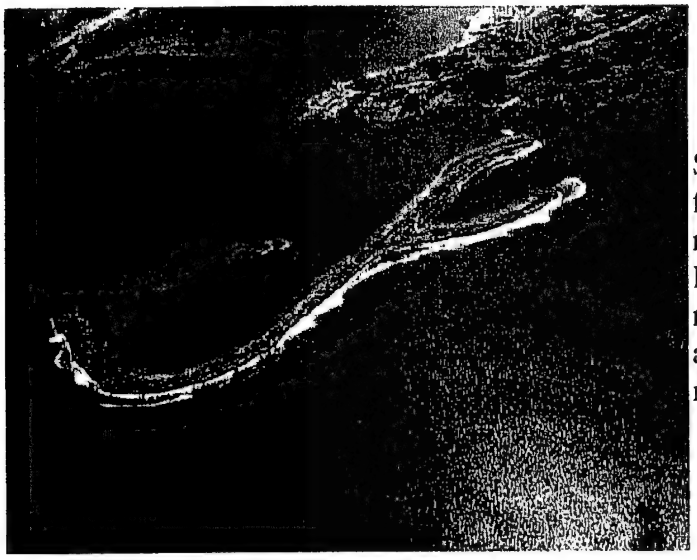


By August 1989, percent cover on Mallard Island was about 33%. Dominant species were winged pigweed, clammyweed, sedge, and marestail. The winged pigweed exhibited a similar response as it did to fertilization on Lost Island with unusually large plants.

WEAVER BOTTOMS

In August 1995, Mallard Island had 21% cover. The most important species were clover, sand dropseed, and marestail. Contrary to expectations, a high percent cover of vegetation never established. A possible reason was a lack of viable seeds in the dredged material because the dredged material was "old" (it came from a depth of up to 14 feet below the lake bottom).

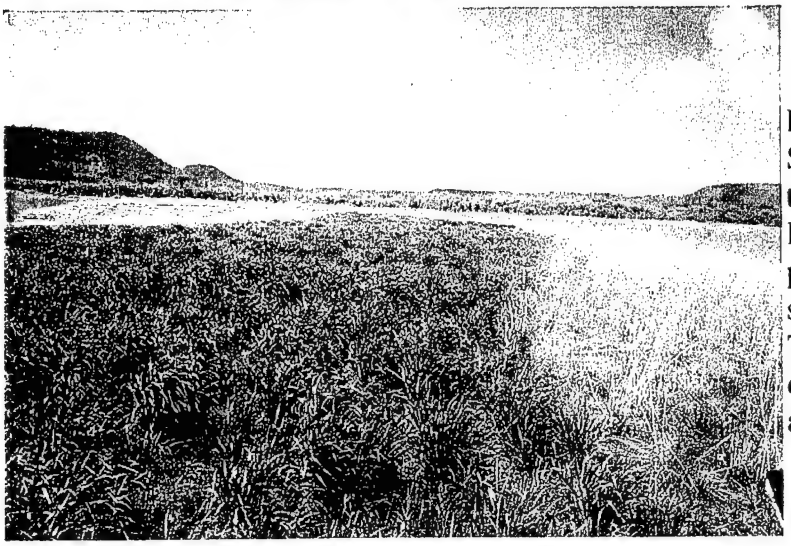
In October 1991, Waterways Experiment Station personnel conducted bioengineering projects on Mallard Island. Willow mats, willow cuttings, wattles, coconut rolls, aquatic plantings, and other techniques were employed to help reduce shoreline erosion.



Swan Island was capped with fine sediment and seeded with native grasses in June 1988. Rock groins, off-shore rock mounds, willow cuttings, and aquatic plants were used to reduce shoreline erosion.

WEAVER BOTTOMS

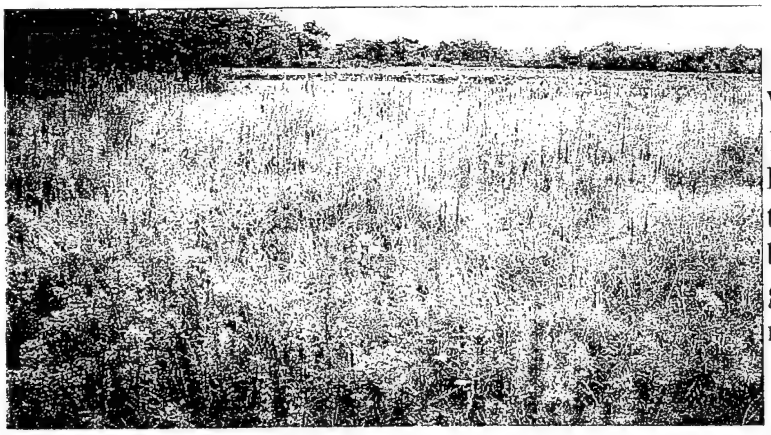
In April 1991, the U.S. Fish and Wildlife Service burned Swan Island in an effort to encourage the growth of the native grasses. Only the top central portion of the island had enough fuel to carry the fire.



In May 1991, the burned portion of Swan Island had 86% cover while the unburned portion had 47%. Dominant species on the burned portion were Canada wild rye, switchgrass, and side oats grama. The unburned portion was dominated by side oats grama, alfalfa, and switchgrass.

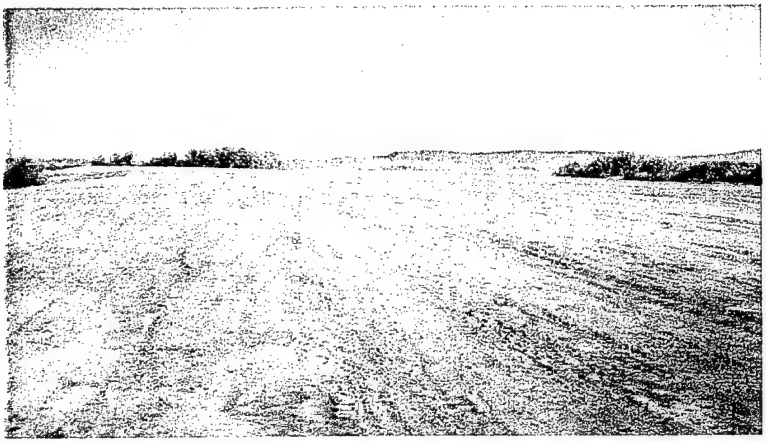
Overall percent cover on Swan Island in August 1995 was 51%. Dominant species were switchgrass, side oats grama, clammyweed and ragweed. The burn did not appear to have long-term benefits.

WEAVER BOTTOMS



Wisconsin closure WI 10 in August 1989. Percent cover was 56%. From year to year, percent cover on the Wisconsin closures varied between 40% and 60%. Native grasses, black-eyed Susan, and marestail were common species.

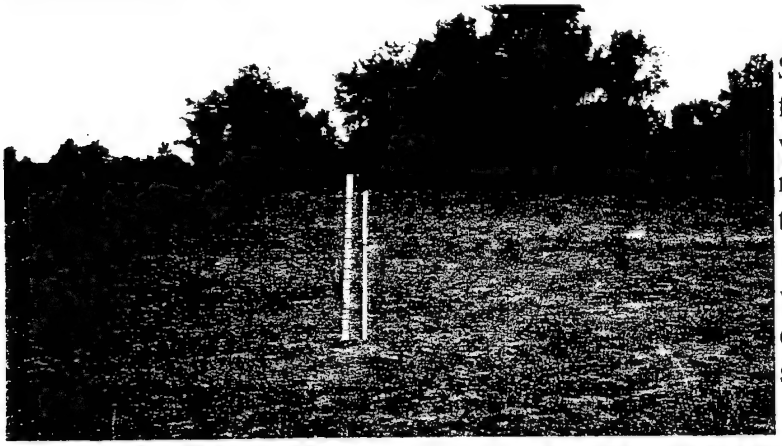
Site MN 10 was the control treatment. It did not receive any fine material or seeding. In August 1995, percent cover was 12%. Percent cover was always around 12% over the study. Common species were sand dropseed, purple sandgrass, and wormwood.



Site MN 11 received fine material and was seeded in July 1988. This August 1988 photo shows no cover. Seeded species were little bluestem, side oats grama, and switchgrass.

In August 1995, percent cover was 64% on site MN 11. Over the years, percent cover was relatively stable. Side oats grama and switchgrass were well established on the site. They are some of the more dependable species for planting.

WEAVER BOTTOMS



Site MN 12 was bare sand with no fine sediment. The site was seeded with sand dropseed, which is also a natural invader on sand sites along the river. In August 1991, it had 17% cover. The dominant species were winged pigweed, sand dropseed, clammyweed, and purple sandgrass.

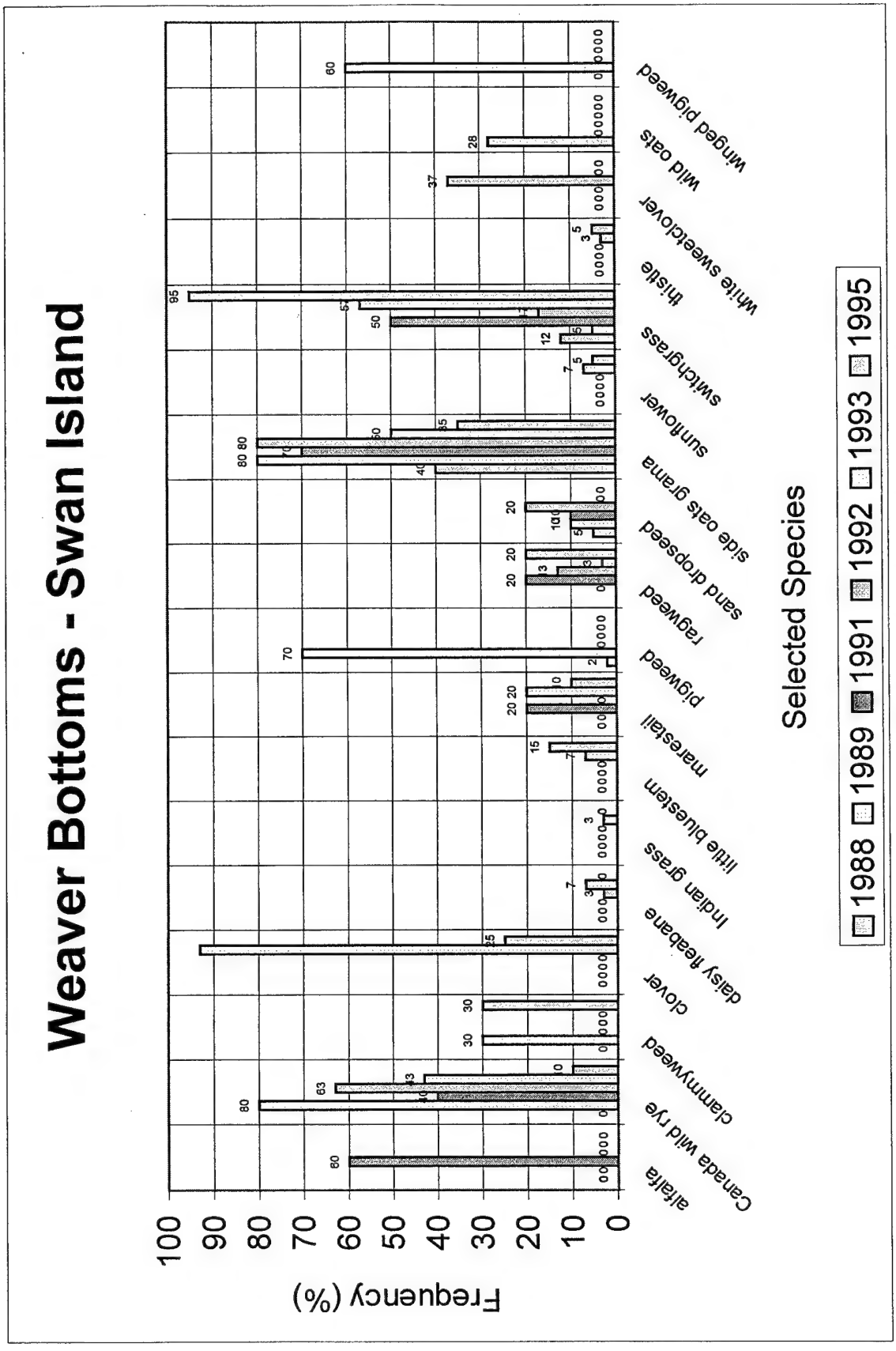
American beachgrass stolons were planted on MN 12 in July 1988. In August 1988, beachgrass was expanding vegetatively on the site. Beachgrass was well suited to these sandy sites.

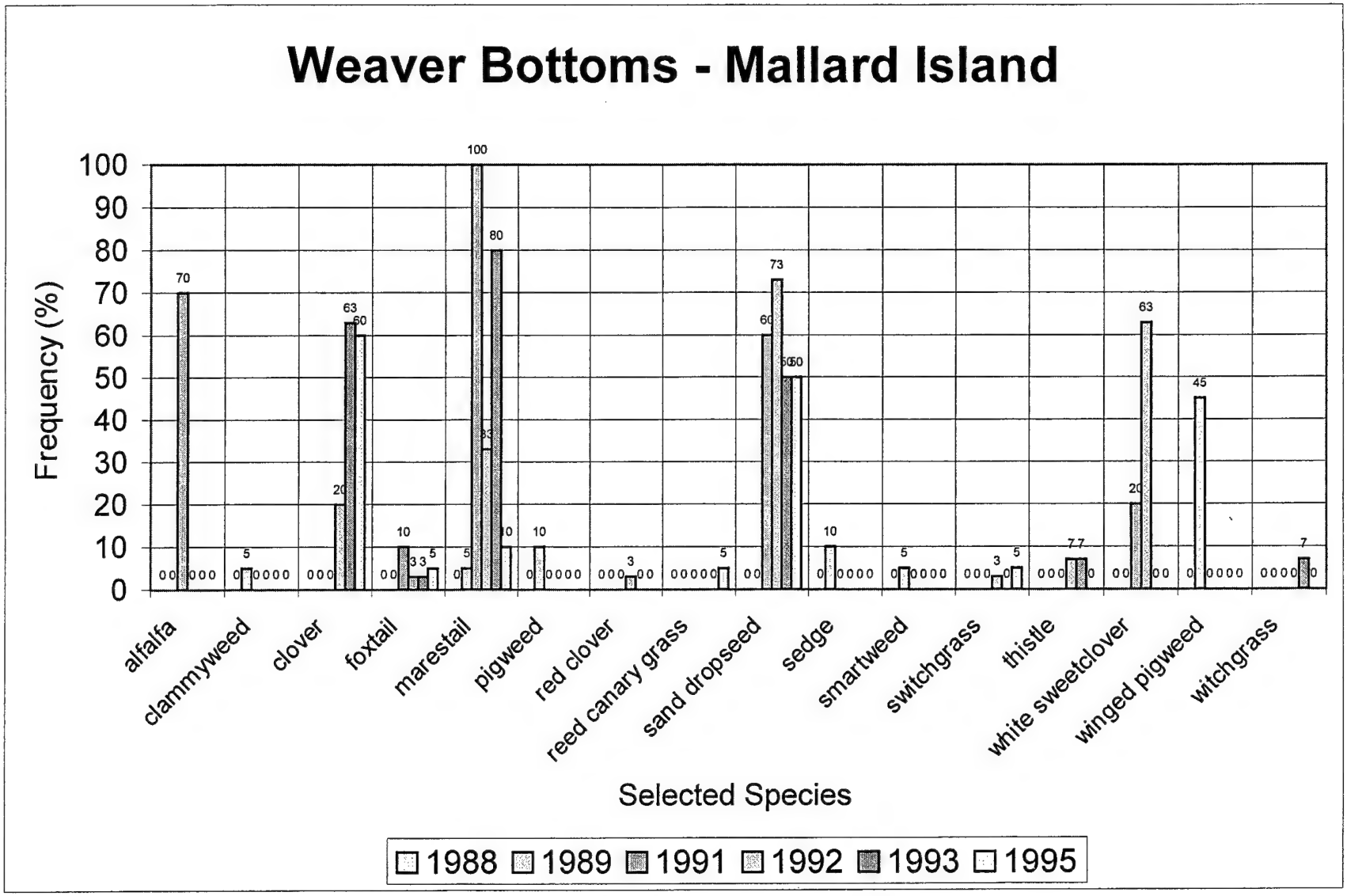
The summer flood of 1993 inundated much of the beachgrass, but some stolons survived. This August 1993 photo shows the inundated area with high mortality. The surviving stolons expanded vegetatively and were common on the site in 1995.

Site MN 13 received fine material and was seeded to wheatgrass, needlegrass, and Canada wild rye. In August 1995, percent cover was 24%. Canada wild rye was the only species to become established on the site.

SUMMARY TABLE OF WEAVER BOTTOMS SURVEY DATA

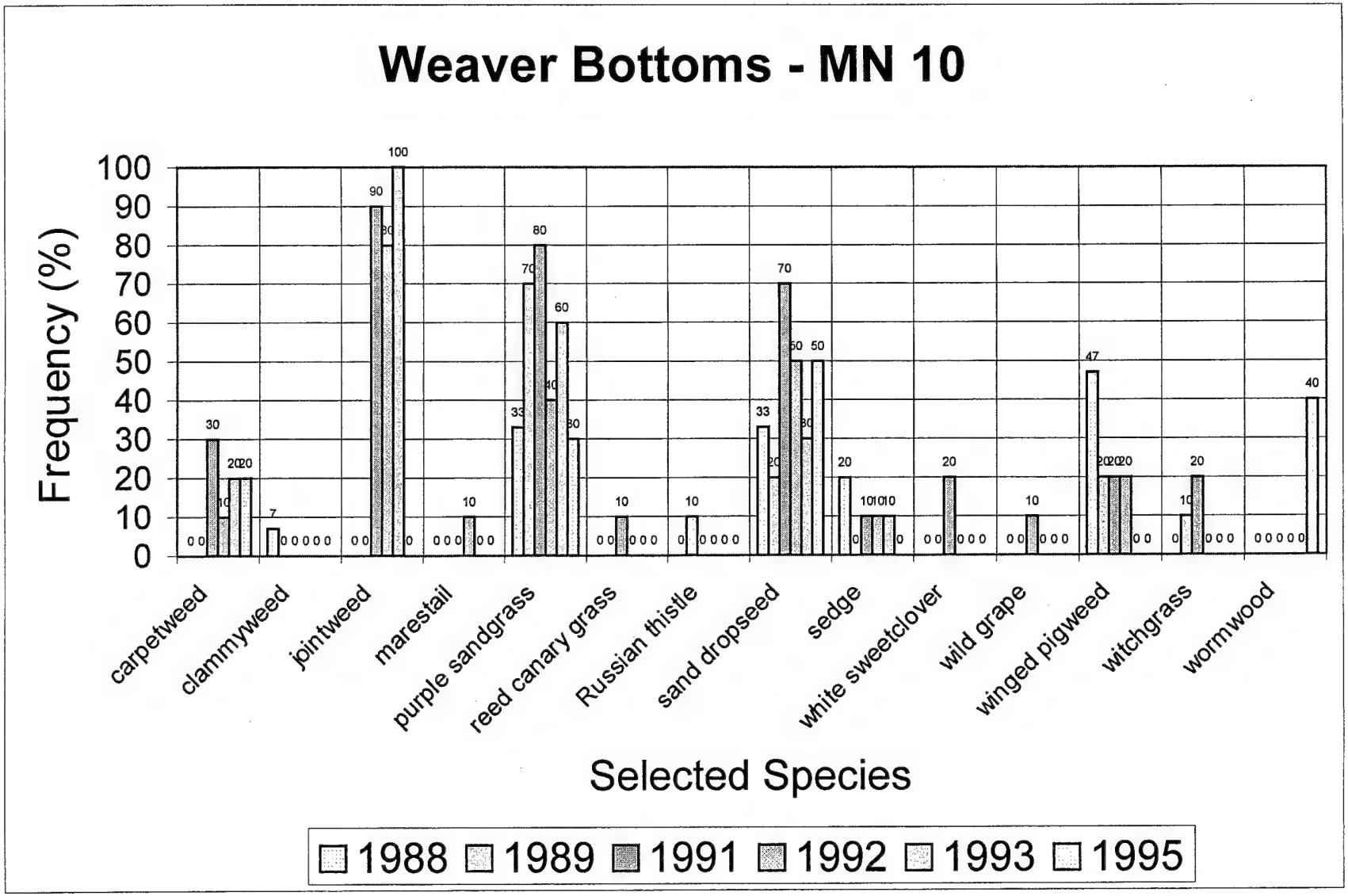
* seeded species	Frequency						Relative Frequency						Dominance						Relative Dominance						Importance Value					
	8/1988	8/1989	9/1991	8/1992	8/1993	8/1995	8/1988	8/1989	9/1991	8/1992	8/1993	8/1995	8/1988	8/1989	9/1991	8/1992	8/1993	8/1995	8/1988	8/1989	9/1991	8/1992	8/1993	8/1995	8/1988	8/1989	9/1991	8/1992	8/1993	8/1995
Weaver Bottoms-Swan Island-Top-Unburned																														
alfalfa			60						22						10						21						21			
*Canada wild rye		80	40	63	43	10		24	15	26	15	4			8	6	3	2			16	11	4	3			15	19	9	3
clammyweed		30				30		9				11						2						4						8
clover					93	25					32	9					47	2					60	5					46	7
cocklebur						5						2						0.2						0.5						1
daisy fleabane				3	7					1	2					0.3	1				0.6	1					1	2		
foxtail						5						2						0.2						0.5						1
*Indian grass					3						1						0.1					0.2						1		
*little bluestem					7	15					1	6					0.5	1				0.6	3					1	4	
marestail			20		20	10			7		7	4			1		3	1			1		4	2			4		5	3
pigweed	2	70					3	21																						
ragweed			20	13	3	20			7	6	1	7			2	0.5	0.2	4			5	0.8	0.2	9			6	3	1	8
*sand dropseed	5	10	10	20			6	3	4	8					1	2					2	3					3	6		
*sand reedgrass																														
*side oats grama	40	80	70	80	50	35	48	24	26	33	17	13			20	35	10	6			40	59	13	12			33	46	15	13
sumac						10						4						0.5						1						1
sunflower					7	5					2	2					0.3	0.2					0.4	0.5					1	1
*switchgrass	12	5	50	17	57	95	14	1	18	7	19	35			8	4	13	29			15	8	17	59			16	7	18	47
thistle					3	5					1	2					0.2	0.2					0.2	0.5					1	1
unknown grass				3						1						2						4						2		
white sweetclover				37						15						8						13						14		
wild oats	28						31																							
winged pigweed		60						18																						
yellow sweetclover				3						1						0.7						1						1		
Average % cover	4	54	66	59	77	51																								
Robel (decimeters)			1.8	2.6	3.1	3.5																								
Weaver Bottoms-Swan Island-SIDE																														
*big bluestem																														
*Canada wild rye		25						8																						
clammyweed		15						5																						
foxtail		5						2																						
goosefoot		5						2																						
*Indian grass																														
lovegrass		5						2																						
marestail		10						3																						
pigweed	2	85					2	28																						
*prairie cordgrass																														
ragweed		10						3																						
sand dropseed		15						5																						
side oats grama	48	80					33	27																						
*switchgrass	12						9																							
wild oats	82						57																							
winged pigweed		45						15																						
Average % cover	14	59																												
Weaver Bottoms - Swan Island - TOP - Burned																														
*Canada wild rye			80						38						44						51						44			
*Indian grass																														
*little bluestem																														
marestail			10						5						0.5						0.5						3			
ragweed			20						9						6						7						8			
*sand dropseed																														
*sand reedgrass																														
*side oats grama			50						24						8						9						16			
*switchgrass			50						24						28						32						28			
Average % cover			86																											
Robel (decimeters)			8.8																											
Weaver Bottoms-Mallard Island-TOP																														
alfalfa			70						26						27						42						34			
clammyweed	0	5					0	6																						
clover				20	63	60				8	29	43				2	16	8				6	49	37				7	39	40
foxtail			10	3	3	5			4	1	2	4			0.5	0.1	0.1	0.5			0.8	0.2	0.5	2			2	0.7	1	3
lambsquarters						5						4						0.2						1						2
marestail	0	5	100	33	80	10	0	6	37	13	36	7			24	2	8	1			37	5	23	6			37	9	30	7
pennycress				20						8						0.9						2						5		
pigweed	0	10					0	12																				1		
red clover				3						1						0.3					0.8									
reed canary grass						5						4						0.5						2						3
sand dropseed			60	73	50	50			22	28	23	36			10	11	6	10			15	26	20	45			18	27	21	40
sedge	0	10					0	12																						
smartweed	0	5					0	6																						
switchgrass				3		5				1		4				0.3		1				0.8		5				1		5
thistle				7	7					2	3					0.3	2					0.8	5					2	4	
unidentified broadleaf					10						5						0.7						2						3	
unknown grass				37						14						5						12						13		
white champion			10						4						1						2						3			
white sweetclover			20	63					7	24					2	18					4	45					5	35		
winged pigweed	0	45					0	56																						
witchgrass					7						3						0.3						1						2	
Average % cover	0	33	84	39	32	21																								
Robel (decimeters)			1.6	1.8	0.6	0.5																								

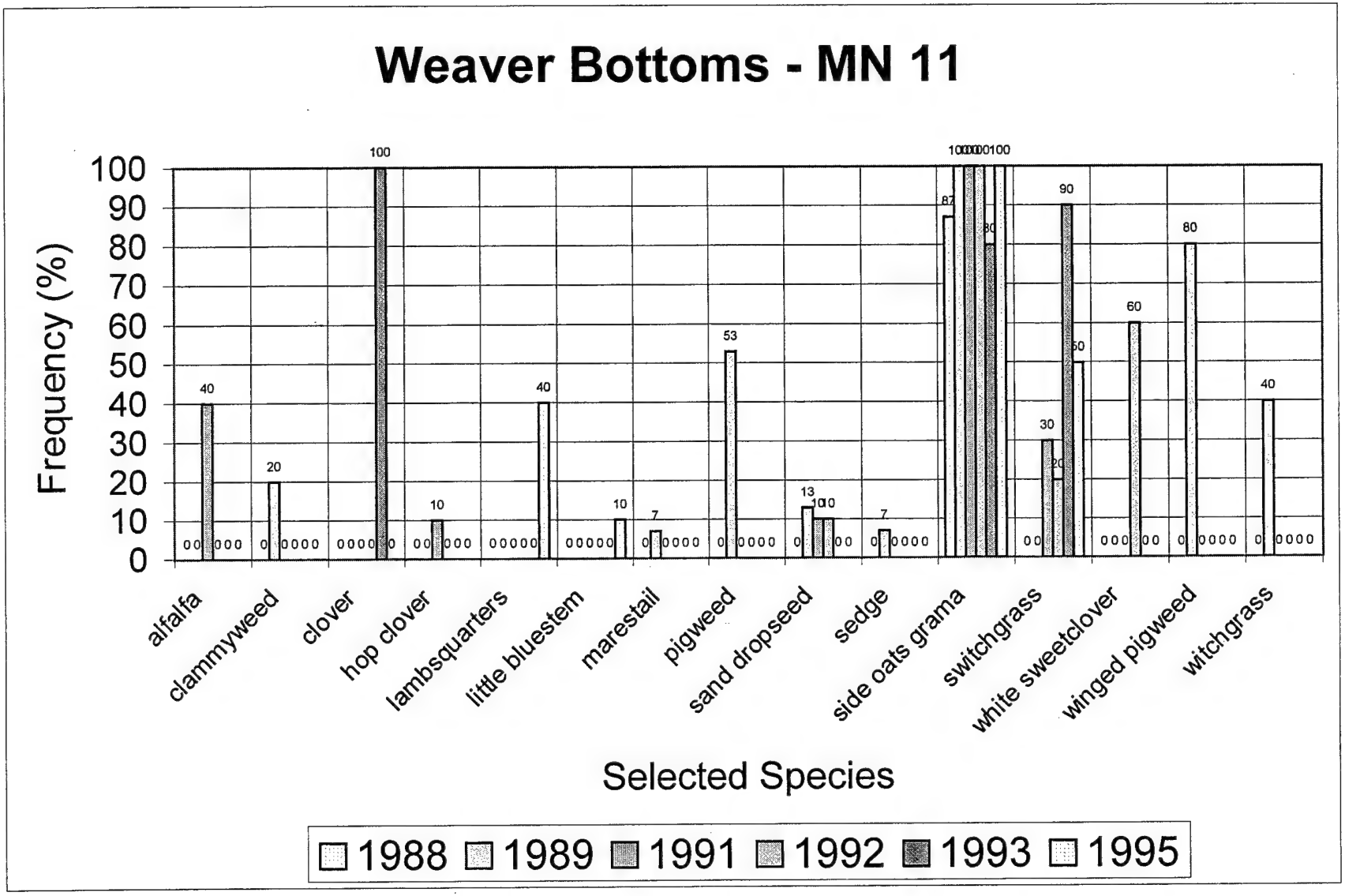

Weaver Bottoms - Swan Island
Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
alfalfa
Canada wild rye
clammyweed
clover
daisy fleabane
Indian grass
little bluestem
marestail
pigweed
ragweed
sand dropseed
side oats grama
sunflower
switchgrass
thistle
white sweetclover
wild oats
winged pigweed
Selected Species
1988 1989 1991 1992 1993 1995


Weaver Bottoms - Mallard Island
Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
alfalfa
clammyweed
clover
foxtail
marestail
pigweed
red clover
reed canary grass
sand dropseed
sedge
smartweed
switchgrass
thistle
white sweetclover
winged pigweed
witchgrass
Selected Species
1988
1989
1991
1992
1993
1995

SUMMARY TABLE OF WEAVER BOTTOMS SURVEY DATA (continued)

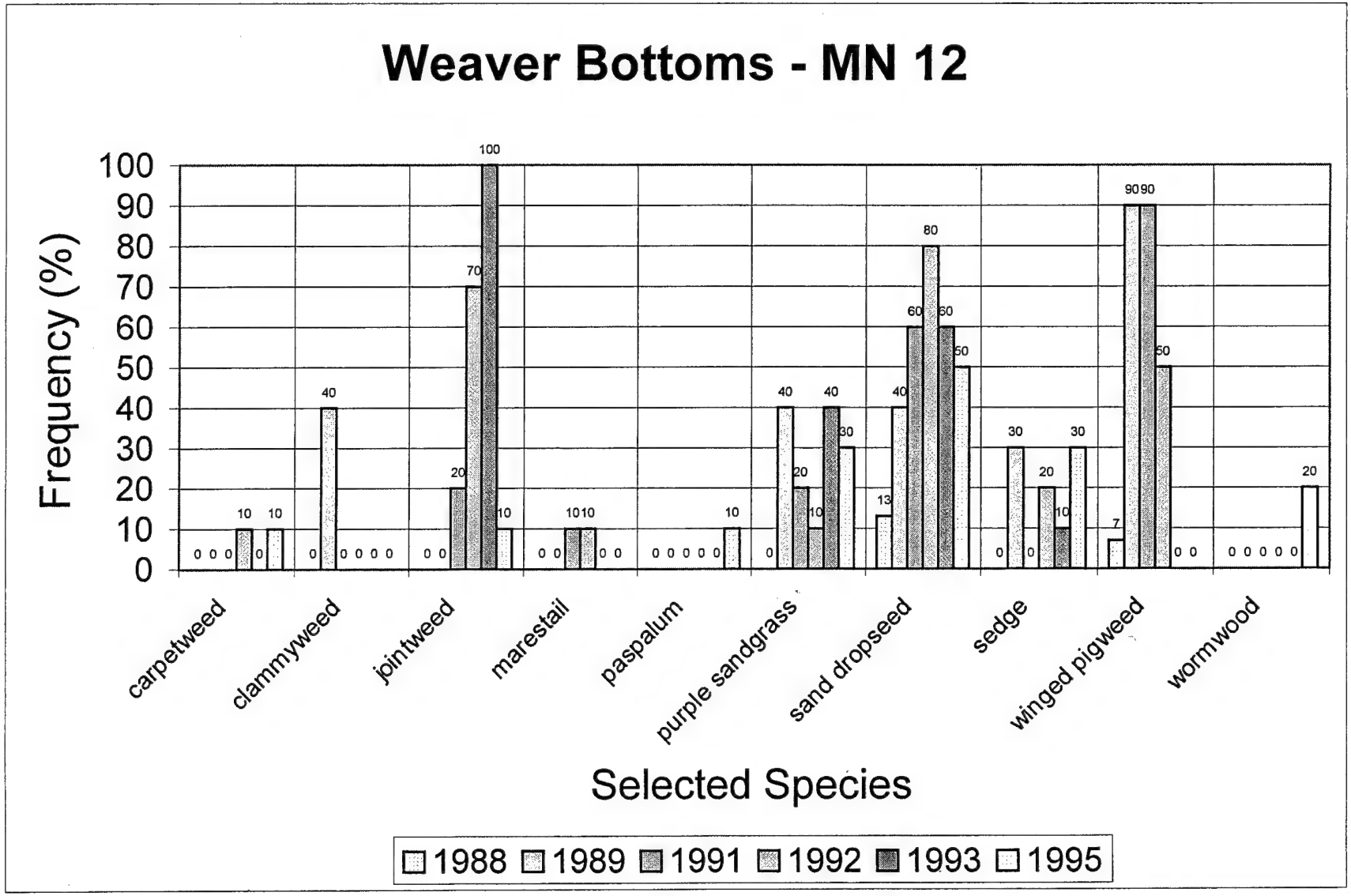
* seeded species	Frequency						Relative Frequency						Dominance						Relative Dominance						Importance Value					
	8/1988	8/1989	9/1991	8/1992	8/1993	8/1995	8/1988	8/1989	9/1991	8/1992	8/1993	8/1995	8/1988	8/1989	9/1991	8/1992	8/1993	8/1995	8/1988	8/1989	9/1991	8/1992	8/1993	8/1995	8/1988	8/1989	9/1991	8/1992	8/1993	8/1995
Weaver Bottoms-Mallard Island-SIDE																														
clammyweed	0	15					0	17																						
pigweed	0	25					0	28																						
winged pigweed	0	50					0	56																						
Average % cover	0	36																												
MN 10-TOP																														
carpetweed			30	10	20	20			8	5	9	14			4	2	1	1			13	17	10	11			10	11	10	13
clammyweed	7						5																							
jointweed			90	80	100				25	36	45				5	3	3				18	25	26				21	31	36	
marestail				10						5						0.5						4						4		
purple sandgrass	33	70	80	40	60	30	24	54	22	18	27	21			3	3	3	3			12	28	27	28			17	23	27	25
reed canary grass			10						3						1						4						3			
Russian thistle		10						8																						
sand dropseed	33	20	70	50	30	50	24	15	19	23	14	36			7	2	4	6			27	19	32	52			23	21	23	44
sedge	20		10	10	10		14		3	5	5				0.2	0.2	0.6				0.7	2	5				2	3	5	
white sweetclover			20						6						2						6						6			
wild grape			10						3						4						14						8			
winged pigweed	47	20	20	20			33	15	6	9					1	0.6					3	5					4	7		
witchgrass		10	20					8	6						1						3						4			
wormwood						40						29						1						8						19
Average % cover	13	13	24	11	12	12																								
Robel (decimeters)			0.6	0	0	0																								
MN 10-SIDE																														
carpetweed		10						8																						
clammyweed	20						20																							
purple sandgrass	13	80					13	67																						
Russian thistle	7						7																							
sand dropseed	13	10					13	8																						
winged pigweed	47	10					13	67																						
witchgrass		10						8																						
Average % cover	7	16																												
MN 11-TOP																														
alfalfa			40						21						8						15						18			
clammyweed		20						6									38						54						46	
clover					100						37																			
crabgrass	7						7																							
hop clover			10						5						1						2						3			
lambsquarters						40						20						2						3						11
* little bluestem						10						5						2						4						4
marestail		7						2																						
pigweed		53						17																						
sand dropseed		13	10	10				4	5	5					0.2	0.5					0.3	0.8					3	3		
sedge		7						2																						
* side oats grama	87	100	100	100	80	100	93	31	53	53	30	50			45	55	16	56			79	86	22	88			66	69	26	69
* switchgrass			30	20	90	50			16	11	33	25			2	2	16	4			4	2	24	5			10	6	28	15
white sweetclover				60						32						7						11						21		
winged pigweed		80						25																						
witchgrass		40						12																						
Average % cover	1	51	56	62	69	64																								
Robel (decimeters)			1.7	1.2	2.5	1.1																								
MN 11-SIDE																														
crabgrass	6						5																							
foxtail		7						2																						
* little bluestem																														
marestail		20						7																						
peppergrass		13						4																						
pigweed	12	47					11	16																						
purslane	24						21																							
sand dropseed		27						9																						
* side oats grama	24	100					21	34																						
* switchgrass	47	7					42	2																						
winged pigweed		53						18																						
witchgrass		20						7																						
Average % cover	8	63																												

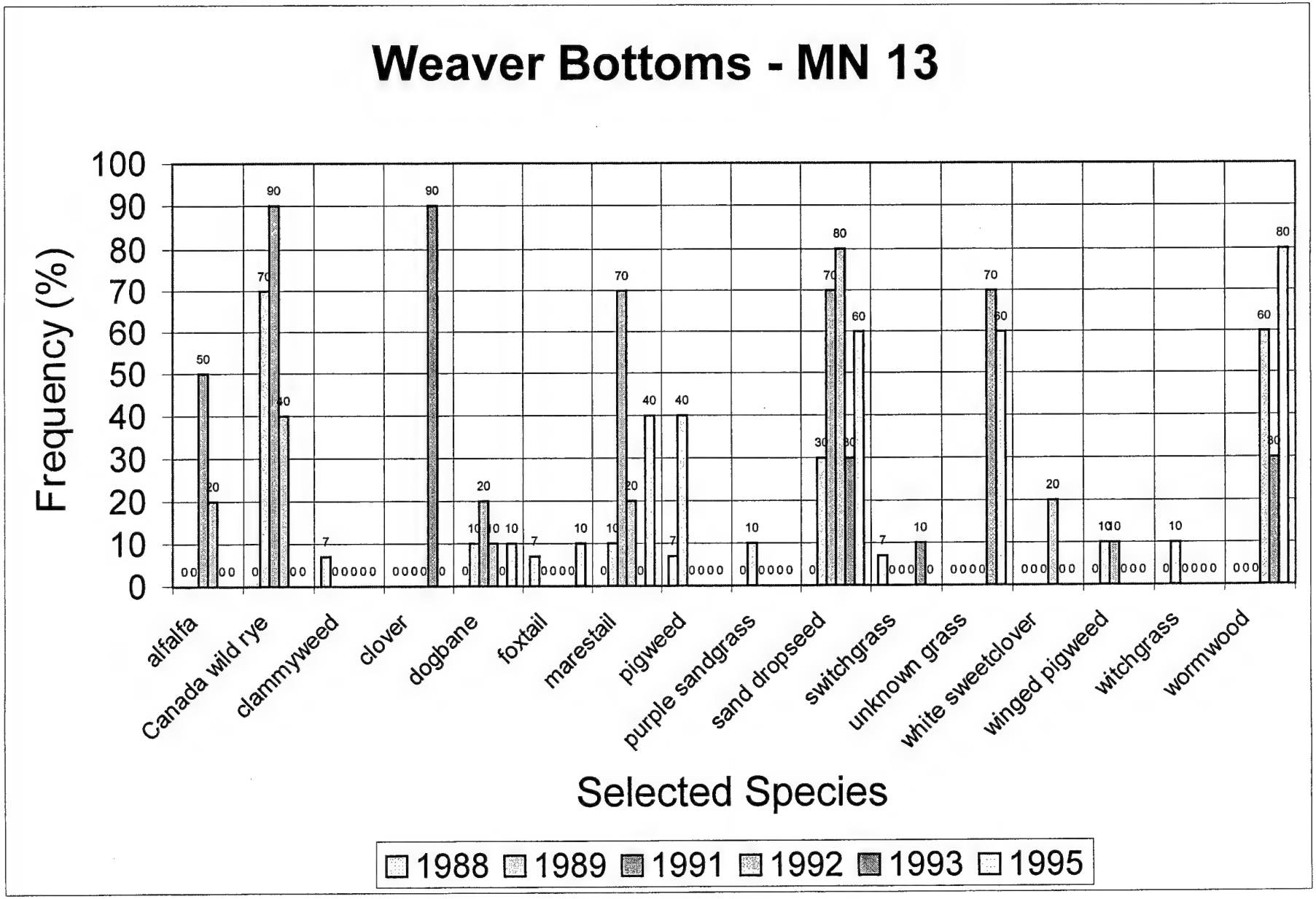

Weaver Bottoms - MN 10
Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
carpetweed
clammyweed
jointweed
marestail
purple sandgrass
reed canary grass
Russian thistle
sand dropseed
sedge
white sweetclover
wild grape
winged pigweed
witchgrass
wormwood
Selected Species
1988
1989
1991
1992
1993
1995


Weaver Bottoms - MN 11
Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
alfalfa
clammyweed
clover
hop clover
lambsquarters
little bluestem
marestail
pigweed
sand dropseed
sedge
side oats grama
switchgrass
white sweetclover
winged pigweed
witchgrass
Selected Species
1988
1989
1991
1992
1993
1995

SUMMARY TABLE OF WEAVER BOTTOMS SURVEY DATA (continued)

* seeded species	Frequency						Relative Frequency						Dominance						Relative Dominance						Importance Value					
	8/1988	8/1989	9/1991	8/1992	8/1993	8/1995	8/1988	8/1989	9/1991	8/1992	8/1993	8/1995	8/1988	8/1989	9/1991	8/1992	8/1993	8/1995	8/1988	8/1989	9/1991	8/1992	8/1993	8/1995	8/1988	8/1989	9/1991	8/1992	8/1993	8/1995
MN 12-TOP																														
*American beachgrass																														
carpetweed				10		10				4		6				0.2		0.2				2		2				3		4
clammyweed		40						17																						
jointweed			20	70	100	10			10	28	46	6			0.7	2	5	0.2			4	18	27	2			7	23	37	4
marestail			10	10					5	4					0.5	0.5					3	4					4	4		
paspalum						10						6						1						9						8
purple sandgrass		40	20	10	40	30		17	10	4	5	19			0.7	0.1	2	2			4	0.8	13	16			7	2	16	17
*sand dropseed	13	40	60	80	60	50	67	17	30	32	29	31			4	8	11	7			22	65	59	50			26	48	44	41
sedge		30		20	10	30		12		8	5	19				0.4	0.2	1				3	1	9				6	3	14
winged pigweed	7	90	90	50			33	38	45	20					12	1					67	8					56	14		
wormwood						20						12						2						12						12
Average % cover	2	15	17	13	18	13																								
Robel (decimeters)			0.2	0	0	0.1																								
MN 12-SIDE																														
*American beachgrass																														
marestail		20						11																						
purple sandgrass		90						47																						
*sand dropseed	7	30					100	16																						
winged pigweed		50						26																						
Average % cover	1	17																												
MN 13-TOP																														
alfalfa			50	20					15	6					12	2					31	5					23	5		
*Canada wild rye		70	90	40				27	27	12					12	2					31	6					29	9		
clammyweed	7						25																							
clover					90						39						46						73						56	
cocklebur			10						3						1						3						3			
dogbane		10	20	10		10		4	6	3		4			2	0.2		0.2			4	0.5		0.8			5	2		2
foxtail	7					10	25					4						0.5						2						3
*green needlegrass				30						9						10						24						17		
marestail		10	70	20		40		4	21	6		14			4	1		2			11	2		7			16	4		11
mustard						20						7						1						4						6
pigweed	7	40					25	15																						
purple sandgrass		10						4																						
sand dropseed		30	70	80	30	60		12	21	24	13	21			7	8	2	6			19	20	3	27			20	22	8	24
sedge			10						3						0.3						0.7						2			
switchgrass	7				10		25				4						4						6						5	
unknown grass					70	60					30	21					8	6					13	23					22	22
*wheatgrass		70		50				27		15						8						18						17		
white sweetclover				20						6						4						8						7		
winged pigweed		10	10					4	3						0.2						0.5						2			
witchgrass		10						4																						
wormwood				60	30	80				18	13	29																16	9	32
Average % cover	1	39	37	40	65	24																								
Robel (decimeters)			0.8	0.7	1.9	0.3																								
MN 13-SIDE																														
*Canada wild rye		70						26																						
foxtail		10						4																						
*green needlegrass																														
marestail		10						4																						
pigweed		70						26																						
purple sandgrass		10						4																						
*rice cutgrass																														
Russian thistle		20						7																						
sand dropseed		20						7																						
switchgrass	27						50																							
*wheatgrass		40						15																						
wild oats	27						50																							
winged pigweed		10						4																						
witchgrass		10						4																						
Average % cover	1	26																												


Weaver Bottoms - MN 12
Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
carpetweed
clammyweed
jointweed
marestail
paspalum
purple sandgrass
sand dropseed
sedge
winged pigweed
wormwood
Selected Species
1988
1989
1991
1992
1993
1995

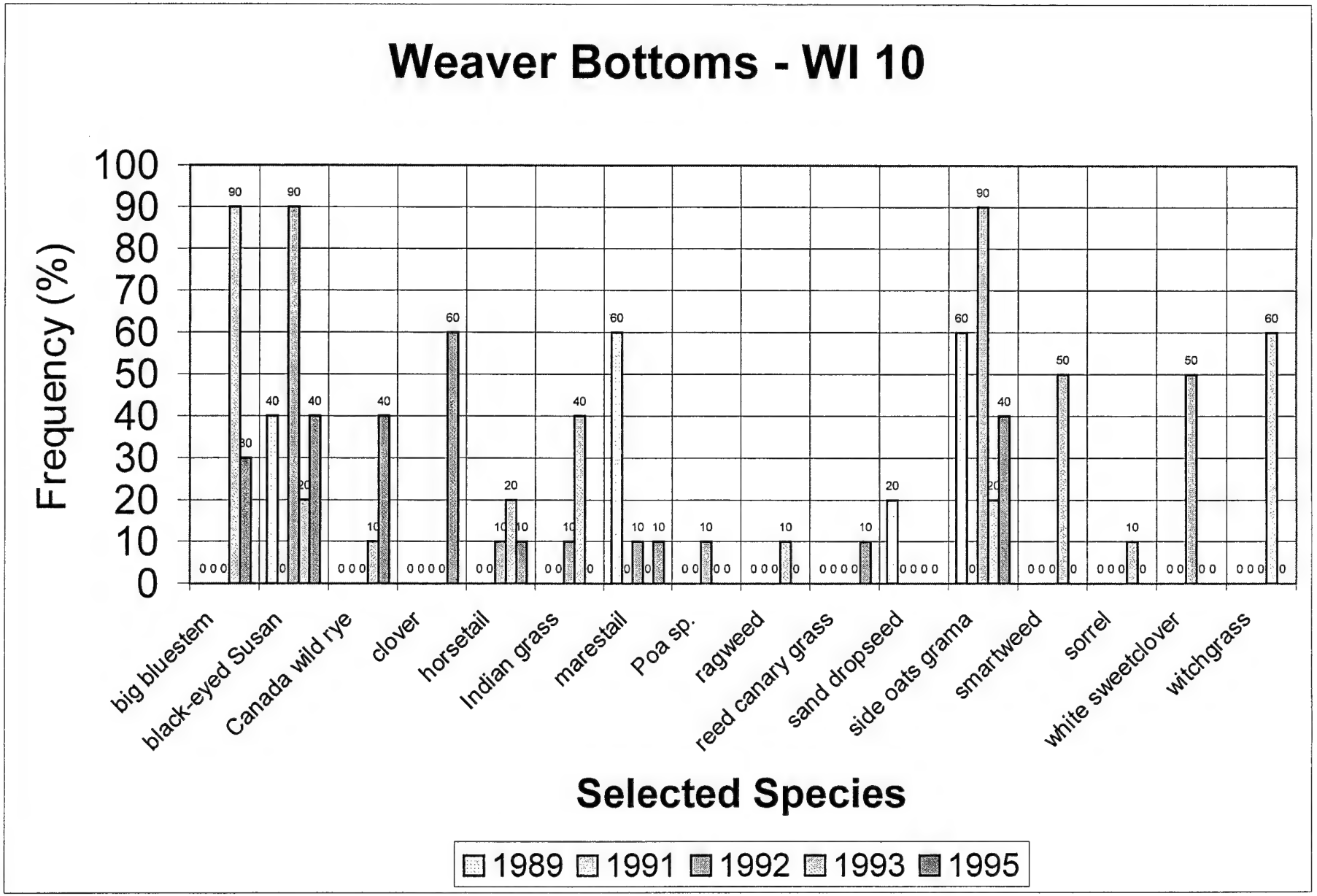

Weaver Bottoms - MN 13
Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
alfalfa
Canada wild rye
clammyweed
clover
dogbane
foxtail
marestail
pigweed
purple sandgrass
sand dropseed
switchgrass
unknown grass
white sweetclover
winged pigweed
witchgrass
wormwood
Selected Species
1988
1989
1991
1992
1993
1995

SUMMARY TABLE OF WEAVER BOTTOMS SURVEY DATA (continued)

* seeded species	Frequency						Relative Frequency						Dominance						Relative Dominance						Importance Value					
	8/1988	8/1989	9/1991	8/1992	8/1993	8/1995	8/1988	8/1989	9/1991	8/1992	8/1993	8/1995	8/1988	8/1989	9/1991	8/1992	8/1993	8/1995	8/1988	8/1989	9/1991	8/1992	8/1993	8/1995	8/1988	8/1989	9/1991	8/1992	8/1993	8/1995
WI 10 B																														
*big bluestem					90	30					26	12					43	10					72	24					48	18
*black-eyed Susan		40		90	20	40		14		33	6	15				8	2	2				16	4	5				25	5	10
blue vervain						10						4						0.5						1						2
*Canada wild rye					10	40					3	15					1	10					2	23					2	19
clover						60						23						7						16						19
foxtail					10						3						0.2						0.3						2	
grass	40						100																							
horsetail				10	20	10				4	6	4				0.5	0.7	0.5				1	1	1				2	3	2
*Indian grass				10	40					4	11					2	5					3	9					3	10	
lovegrass		10						3																						
marestail		60		10		10		4		4		4				0.5		0.5				1		1				2		2
Poa sp.				10						4						0.5						1						2		
*prairie dropseed																														
ragweed					10						3						0.5						1						2	
reed canary grass						10						4						2						6						5
*rough blazing star																														
*sand dropseed		20						7																						
sedge					10						3						0.2						0.3						2	
*showy sunflower																														
*side oats grama		60		90	20	40		21		33	6	15				26	2	10				52	2	23				42	4	19
smartweed					50						14						1						2						8	
sorrel					10						3						0.2						0.3						2	
water horehound						10						4						0.5						1						2
*wheatgrass		100						34																						
white sweetclover				50						18						13						26						22		
witchgrass					60						17						5						8						14	
Average % cover	1	55		48	61	44																								
Robel (decimeters)				2	1	1.4																								
WI 10 C																														
*big bluestem																														
*black-eyed Susan		40						15																						
*Canada wild rye																														
grass	60						100																							
*Indian grass																														
lovegrass		50						18																						
marestail		40						15																						
*prairie dropseed																														
*rough blazing star																														
*sand dropseed																														
*showy sunflower																														
*side oats grama		40						15																						
*wheatgrass		100						37																						
Average % cover	1	59																												

NOTES:

Burned and unburned portion of Swan Island combined in 1992.
Side slopes of side channel closures not monitoring since 1991.
Wisconsin closures combined in 1992.


Weaver Bottoms - WI 10
Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
big bluestem
black-eyed Susan
Canada wild rye
clover
horsetail
Indian grass
marestail
Poa sp.
ragweed
reed canary grass
sand dropseed
side oats grama
smartweed
sorrel
white sweetclover
witchgrass
Selected Species
1989
1991
1992
1993
1995

Island 43, Pool 5, RM 746.5

Erosion Control Measures

In an attempt to control shoreline erosion, various efforts were undertaken at a number of locations in Pool 5. The most notable of these efforts occurred in the vicinity of Island 43 in Pool 5. The site consisted of a steep bank of sloughing sand. In May 1990, the Minnesota and Wisconsin Departments of Natural Resources water jetted willow along the shoreline. The willow were about 3 to 4 feet tall and jetted in clumps. They were placed in the water about 1 foot below the normal water level. In April 1991, the Corps and the Service planted willow and dogwood cuttings along the shoreline in the same area but above the normal water surface elevation. The dogwood and some of the willow cuttings were obtained from areas in Pool 5. Some of the willow cuttings were hybrid willow. The hybrid willow (*Salix alba "Calva"* and *Salix alba "Nova"*) were obtained from the Natural Resources Research Institute in Duluth, Minnesota.

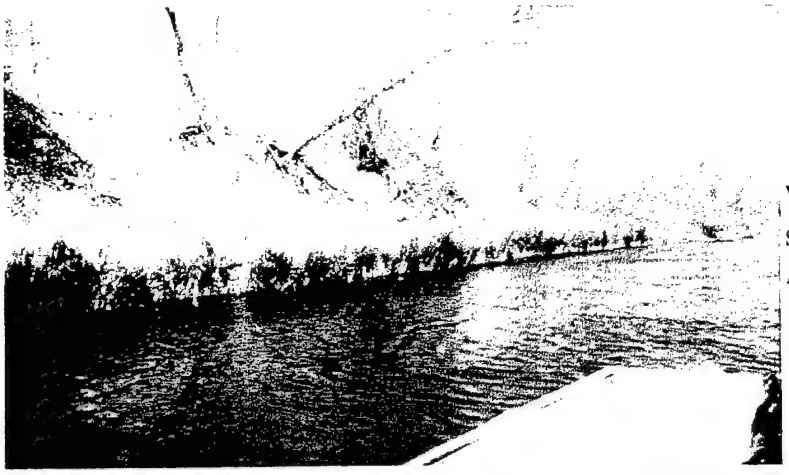
Other erosion control activities in this area included riprap, rock groins, and anchoring dead trees along the shoreline. The effectiveness of these features is not reported here.

Monitoring Results

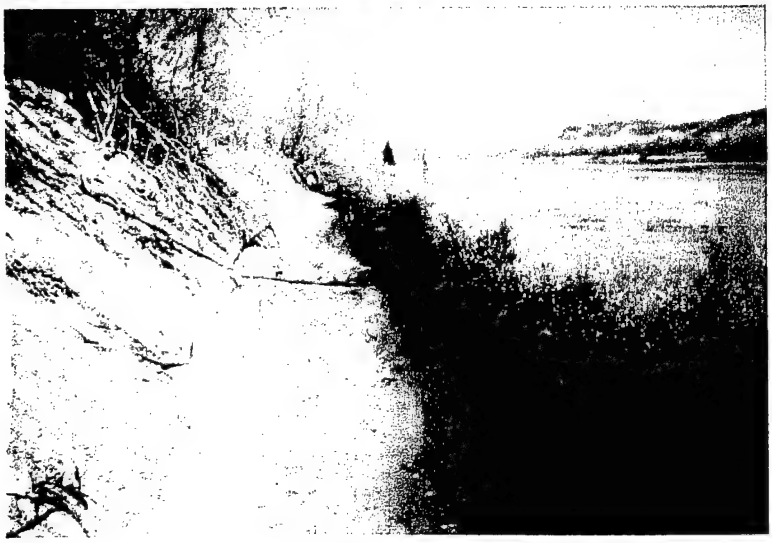
In 1991, the willow that were jetted below the normal water surface elevation were dead. They probably could not tolerate the continuous inundation even though they were not completely submerged. However, the 4-foot-high willow clumps were providing some protection by breaking the wave action. In the fall of 1991, the willow and dogwood planted that spring above the water surface elevation showed mixed results. Some of the cuttings were buried due to bank sloughing. Areas where the cuttings were not buried showed about 70% survival of willow and dogwood. The area was also being colonized by natural willow reproduction.

In August 1992, the jetted willow were all broken off about 6 inches above the water line, presumably by ice that formed during the winter. The willow that were partially buried by bank sloughing showed no signs of growth. The planted and natural willow that were not directly under the cut bank were growing.

ISLAND 43 EROSION CONTROL



Willow were jetted along the shoreline of Island 43 in Pool 5 in April 1991 to reduce erosion.



In May 1991, willow (hybrid and natural) and dogwood cuttings were also planted along the shoreline in back of the jetted willow. The jetted willow appeared to have died due to planting below the normal water level.

Island 43. Site of the 1991 willow plantings for shoreline erosion control.

In August 1992, the jetted willow were all broken off presumably by ice during the winter. Most of the cuttings planted in back of the jetted willow were buried by bank sloughing and did not grow. Cuttings at the upstream end of the site (top of photo) were more protected and grew.

Lake Onalaska Islands, Pool 7, RM 705.0

Vegetation Measures

Lake Onalaska Islands was an HREP project located in Pool 7 near La Crosse, Wisconsin. It was completed in October 1989. Three islands, Broken Gun, Cormorant, and Arrowhead, were constructed of sand and capped with fine sediment in 1989. They were broadcast seeded in June 1990. There is some question as to what species were seeded by the contractor. Either of the following seed mixes may have been planted. In addition, the highway department was using a mix that included bluegrass and birds-foot trefoil. Portions of all of these mixes are found on the islands, and some species that usually germinate have not been recorded. It is possible that some combination of species was actually used.

Species	Seeding Rate
Canada wild rye	5 lbs. PLS/ac.
side oats grama	5 lbs. PLS/ac.
switchgrass	5 lbs. PLS/ac.
perennial ryegrass	10 lbs./ac.

or:

smooth bromegrass	15 lbs./ac.
switchgrass	5 lbs. PLS/ac.
perennial ryegrass	10 lbs./ac.

In the fall of 1994, the La Crosse Office of the Fish and Wildlife Service burned the east half of Broken Gun Island and the west half of Cormorant Island in an effort to stimulate growth. Soil tests conducted by the Fish and Wildlife Service indicated that the soil was deficient in nitrogen. The areas were also fertilized and seeded with red clover and alfalfa.

Monitoring Results

Total percent cover was estimated on the plots. The average percent cover for each of the islands since they were seeded is summarized below.

	Percent Cover (date)						
Island	8/1990	9/1991	8/1992	8/1993	8/1994	8/1995	8/1999
Broken Gun	96	78	52	83	9	65	61
Burned						71	
Not Burned						58	
Cormorant	91	73	71	87	27	71	57
Burned						89	
Not Burned						59	
Arrowhead	89	78	55	71	60	65	62

Figures 11 and 12 summarize the Robel reading and percent cover estimates for the Lake Onalaska Islands.

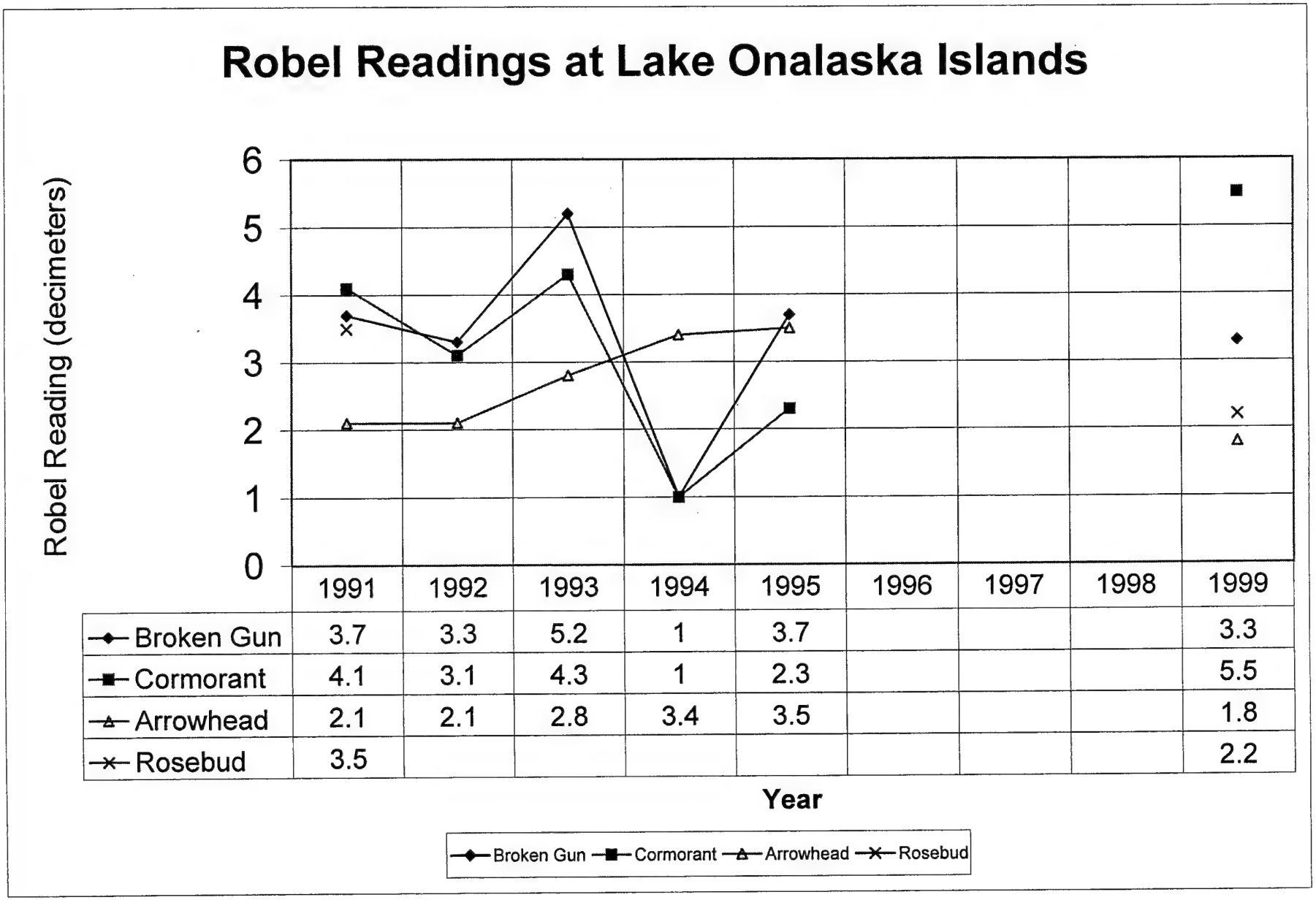


Figure 11. Robel readings for Lake Onalaska Islands HREP project. Low readings in 1994 reflect matted down switchgrass.

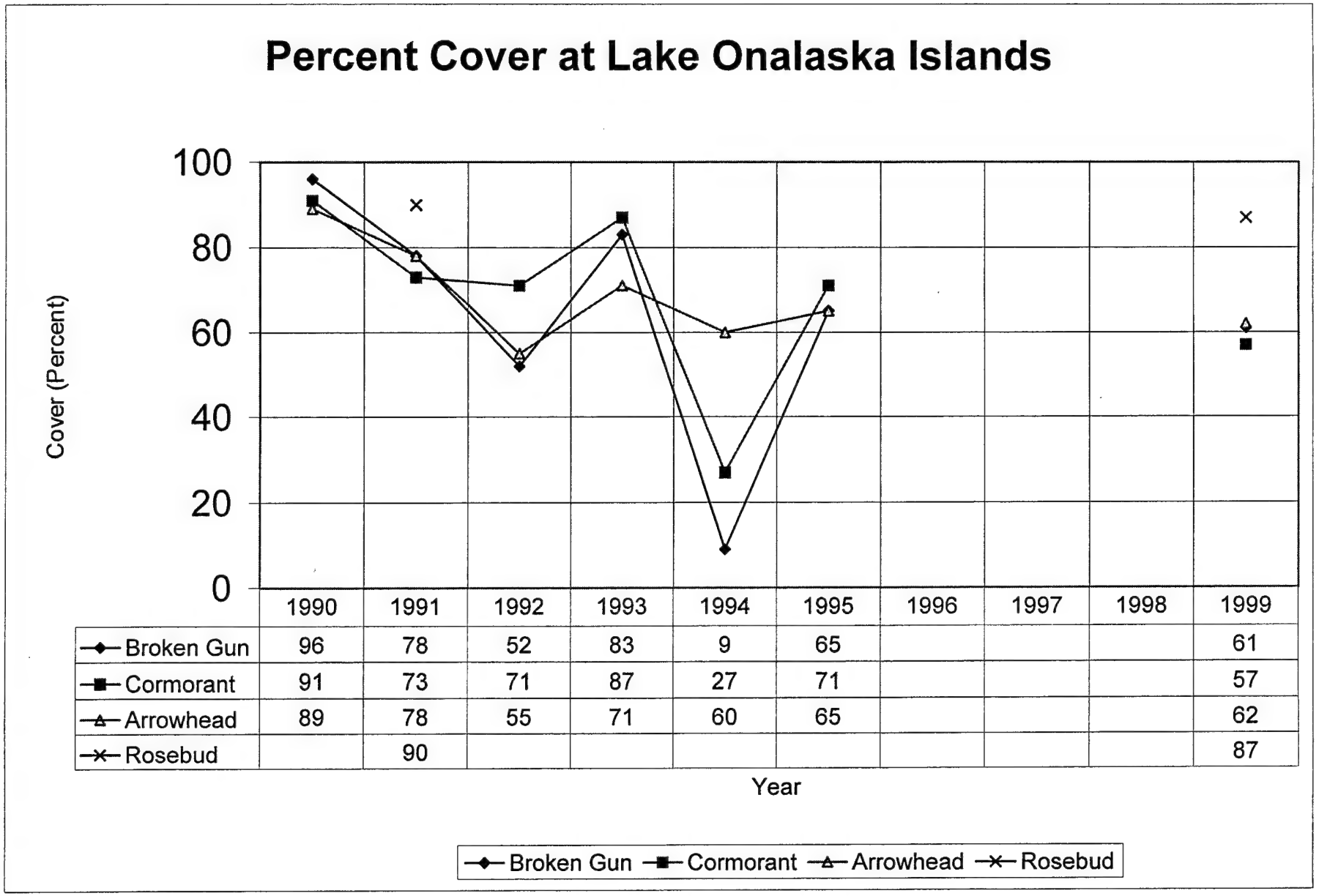


Figure 12. Percent cover estimates for Lake Onalaska Islands HREP project.

In the early years after seeding, vegetation near the ends of the islands was usually taller and denser than vegetation in the center of the islands, which appeared to receive substantial recreational use. For example, in 1992 a local resident stopped by during monitoring activities and said that people bring lawnmowers to Broken Gun Island to cut the grass.

The decline in cover between 1990 and 1991 was probably due to the decline in perennial rye. Robel readings for 1991 and 1992 were very similar. In 1993, the readings increased, as did percent cover, especially on Broken Gun Island, which appeared to have less recreational use.

In August 1994, most of the vegetation on Broken Gun and Cormorant Islands was dead; on Arrowhead Island vegetation appeared to be normal and had a Robel reading of 3.4 decimeters. The August appearance of vegetation on Broken Gun and Cormorant Islands was that of spring, with dead vegetation and a few new green shoots. In many areas the vegetation was matted down; in other areas it was still standing but dead. Robel readings for these two islands were misleading because they reflect a large proportion of dead vegetation.

One hypothesis was that the dense switchgrass growth of previous years smothered the new growth on Broken Gun and Cormorant Islands. The vegetation on Arrowhead Island, which was never as tall or as dense as that on the other two islands, did not decline and supported the hypothesis. Another possible reason was lack of nitrogen identified through soil tests. Discussions with Mr. Jim Nissen, Fish and Wildlife Service - La Crosse, came to the same conclusions and indicated that burning would be helpful; fertilizer was also added on the basis of the soil tests, and legumes were planted. Refuge personnel burned half of Broken Gun and Cormorant Islands in the fall of 1994. The burn and fertilization in the fall of 1994 resulted in an increase in the density of vegetation over the unburned areas, although the ANOVA indicated it was significant only on Cormorant Island. After the burns, the Robel readings on both islands increased substantially in 1995; readings continued to increase on Broken Gun and Cormorant Islands through 1999. In contrast, by 1999 the Robel readings on Arrowhead Island were decreasing. The importance of switchgrass on Arrowhead Island was relatively steady or declining; on Broken Gun and Cormorant Islands, it increased.

An Analysis of Variance (ANOVA) was performed on the percent cover estimates to determine if there was a difference between the islands and from year to year. There was a significant decrease in the percent cover between 1991 and 1992. Some of the variation in cover can be explained by the location of the plots. The central part of the islands is less dense. This is partly due to recreational use. The middle of the islands also could have less fine material, contain more gravel, or be more subject to wind from the north and south. The vegetation on the ends of the islands seemed to be more depressed and knocked by either wind, rain, snow, or a combination of factors. This influences the Robel and percent cover estimates. There was a significant difference in the percent cover on the islands between 1992 and 1993. In 1994, the percent cover was significantly different among all the islands. The burns resulted in significant increases in percent cover on the islands from 1994 to 1995 but not between the islands. There was not a significant difference in the percent cover between the burned and unburned portions of Broken Gun Island. There was a significant difference in the percent cover for Broken Gun

and Cormorant Islands between 1994 and 1995 due to the burn. There was not a significant difference in the percent cover between islands in 1999 or from 1995 to 1999. The Jaccard Index of Species Similarity between the unburned and burned portions of Broken Gun and Cormorant Islands in August 1995 was 42 and 36, respectively. A little less than half of the species were found on both the burned and unburned portions of the islands.

Percent cover was also estimated by species. The frequency, relative frequency, dominance, relative dominance, and importance value were determined for each species observed. The data shows that switchgrass was the dominant species in percent cover and importance and had increased until 1994. In 1994, switchgrass decreased in importance on Broken Gun and Cormorant Islands. In 1995, switchgrass decreased in importance on all of the burned areas but remained dominant or co-dominant on unburned areas. Bluegrass appears to have been little affected by the burn. In 1999, switchgrass gained in importance on Broken Gun and Cormorant Islands. The importance of switchgrass on Arrowhead Island is relatively stable.

Importance values vary between the burned and unburned areas as shown in the following table. The most important species on burned areas in 1995 were reed canary grass and bluegrass. On unburned areas, the most important species were bluegrass and switchgrass. Weedy species were more common in 1995, especially on burned areas.

On the basis of importance value, the dominant species found on the islands are presented below:

Year	Broken Gun Island	Cormorant Island	Arrowhead Island
1991	switchgrass	switchgrass	switchgrass
	perennial rye	perennial rye	perennial rye
	reed canary grass	reed canary grass	side oats grama
1992	switchgrass	switchgrass	switchgrass
	side oats grama	bluegrass	bluegrass
	bluegrass	side oats grama	side oats grama
1993	switchgrass	switchgrass	switchgrass
	bluegrass	bluegrass	side oats grama
	side oats grama	side oats grama	bluegrass
1994	switchgrass	switchgrass	switchgrass
	reed canary grass	reed canary grass	side oats grama
	bluegrass	side oats grama	bluegrass
1995	bluegrass	bluegrass	switchgrass
	reed canary grass	switchgrass	bluegrass
	marestail	reed canary grass	side oats grama
1999	reed canary grass	switchgrass	bluegrass
	bluegrass	bluegrass	switchgrass
	switchgrass	reed canary grass	side oats grama

Importance Values in 1995 after burning

Broken Gun			
Burned		Unburned	
reed canary grass	34	bluegrass	42
bluegrass	22	switchgrass	15
evening primrose	16	marestail	11
Cormorant			
Burned		Unburned	
bluegrass	46	bluegrass	28
reed canary grass	18	switchgrass	27
barnyard grass & foxtail	8	side oats grama	22

Many additional species are found along the shoreline and in the eroded areas. The species composition on the stable seeded portion of the islands is fairly uniform and includes relatively few species as reflected by the plot data.

In approximately 1991, the Fish and Wildlife Service planted some willow cuttings along the shore of Broken Gun Island. A few of these cuttings survived, but portions of the island in this area have eroded.

The Jaccard Index of Species Similarity was calculated for the species found on the sample plots. The index has been fairly stable at about 40 to 50 since the islands were seeded in 1990 but decreased in 1995 and 1999, possibly due to the burn.

Soil samples were collected on each of the islands in September 1994 to determine the percent fine material. Essentially all of the samples represent dense vegetative cover (Broken Gun, 37.0% fine material; Cormorant, 37.7% fine material; Arrowhead, 51.4% fine material).

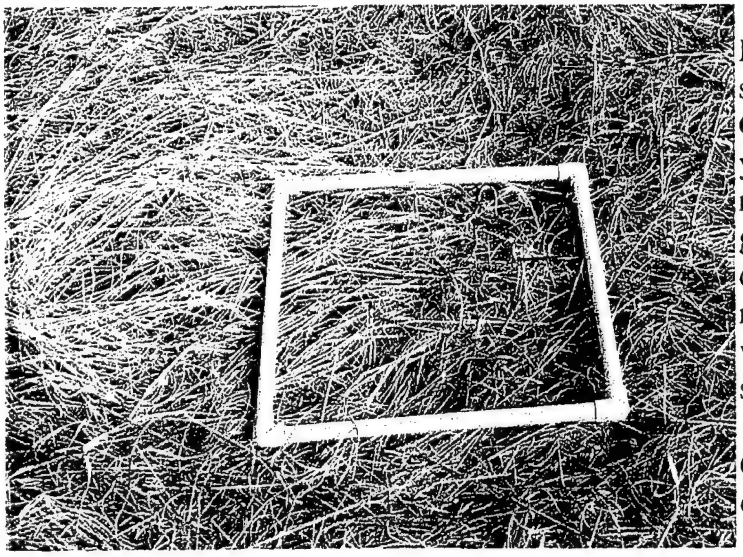
Summary

The vegetation seemed to be well established on the islands until 1994. Switchgrass was the dominant species, and there was an increase in the percent cover and Robel readings between 1992 and 1993. The site visit in 1994 was a total surprise. Both Broken Gun and Cormorant Islands had about 70% to 90% dead vegetation. Also, there seemed to be an increase in the importance of reed canary grass in 1994. The increase in reed canary grass may not be desirable. The fire in 1994 decreased the amount of switchgrass and stimulated growth. Weedy species also increased in 1995. In 1999, the Robel readings further declined and there was a slight decrease in percent cover. Switchgrass is again increasing in importance on Broken Gun and Cormorant Islands.

LAKE ONALASKA ISLANDS

Lake Onalaska Islands HREP project in Pool 7. Three half-moon shaped islands were capped with fine sediments and seeded with grasses in June 1990.

In August 1990, Broken Gun Island had 96% cover.



In August 1994, the dense switchgrass growth on Broken Gun Island from the preceding year formed a dense mat which restricted growth and abundance of grasses. Overall percent cover declined to only 9% with a Robel reading of 1 decimeter. The island was burned in the fall of 1994 to stimulate plant growth. In August 1995, percent cover increased to 65% with a Robel reading of 3.7 decimeters.

LAKE ONALASKA ISLANDS

Cormorant Island, in August 1992, exhibited 71% cover with a Robel reading of 3.1 decimeters. Cover consisted mostly of switchgrass, bluegrass, and side oats grama. Like Broken Gun Island, cover declined to 27% by 1994 due to the matting of switchgrass.

Cormorant Island was also burned in the fall of 1994 to stimulate plant growth. In August 1995, percent cover increased to 71% with a Robel reading of 2.3. Bluegrass, switchgrass, and reed canary grass were dominant species.

Arrowhead Island, in August 1991, had a percent cover of 78% and a Robel reading of 2.1 decimeters. Switchgrass, rye, and side oats grama were common species.

In August 1999, Arrowhead Island had 62% cover and a Robel reading of 1.8 decimeters. Bluegrass, switchgrass, and side oats grama were common. Switchgrass never dominated the site like it did the other two islands; consequently, burning was not necessary to maintain vegetation. All three islands have become important waterfowl nesting areas.

SUMMARY TABLE OF ONALASKA ISLANDS AND ROSEBUD ISLAND SURVEY DATA

* seeded species

Onalaska Islands - Broken Gun

	Frequency							Relative Frequency						
	9/1990	9/1991	8/1992	8/1993	8/1994	8/1995	8/1999	9/1990	9/1991	8/1992	8/1993	8/1994	8/1995	8/1999
bindweed							6.7							2.5
burnweed						12							5	
* Canada wild rye	2							1						
clover		5		5		6			2		3		2	
daisy fleabane						6							2	
dock		5		5					2		3			
evening primrose						19							7	
foxtail	2	5				19	6.7	1	2				7	2.5
lambsquarters						6							2	
marestail						38	20						14	7.5
milkweed							6.7							2.5
* perennial rye	100	70						61	33					
Poa sp.			35	40	27	75	80			20	22	27	27	30
quackgrass			5			19				3			7	
reed canary grass		30		5	40	44	66.7		14		3	40	16	25
* side oats grama			35			12	13.3			20			5	5
sorrel							6.7							2.5
* switchgrass	6	100	100	100	33	19	40	35	47	57	56	33	7	15
unknown broadleaf							20							7.5
Average % cover	96	78	52	83	9	65	61							
Robel (decimeters)		3.7	3.3	5.2	1	3.7	3.3							

	Dominance						Relative Dominance						Importance Value					
	9/1991	8/1992	8/1993	8/1994	8/1995	8/1999	9/1991	8/1992	8/1993	8/1994	8/1995	8/1999	9/1991	8/1992	8/1993	8/1994	8/1995	8/1999
bindweed						0.3						0.5						1.5
burnweed					2						3						4	
* Canada wild rye																		
clover	2		0.8		0.3		2		0.9		0.5		2		2		1	
daisy fleabane					1						1						2	
dock	0.2		0.1				0.3		0.1				1		1			
evening primrose					6						10						8	
foxtail	0.1				2	0.3	0.1				3	0.5	1				5	1.5
lambsquarters					0.3						0.5						1	
marestail					3	0.6					5	1					9	4.2
milkweed						0.1						0.2						1.4
* perennial rye	8						10						21					
Poa sp.		4	10	2	24	17.3		7	12	18	36	27.9		13	17	22	32	28.9
quackgrass		0.1			1			0.2			2			2			4	
reed canary grass	6		0.2	3	19	28.3	8		0.3	35	30	45.6	11		2	38	23	35.3
* side oats grama		3	2		1	0.7		6	2		1	1.1		13	8		3	3
sorrel						0.1						0.2						1.4
* switchgrass	64	46	72	4	5	11.3	80	87	85	47	8	18.2	63	72	70	40	7	16.6
unknown broadleaf						3						4.8						6.2

Onalaska Islands - Cormorant

	Frequency							Relative Frequency						
	9/1990	9/1991	8/1992	8/1993	8/1994	8/1995	8/1999	9/1990	9/1991	8/1992	8/1993	8/1994	8/1995	8/1999
alfalfa						7							2	
barnyard grass						7							2	
burnweed						7							2	
* Canada wild rye														
clover						7							2	
dandelion		5							2					
dock		5							2					
evening primrose						13							5	
foxtail	2					20	6.7	1					8	4
lambsquarters						7							2	
marestail							20							12
* perennial rye	100	65						54	32					
Poa sp.			70	75	53	80	46.7			38	36	28	30	28
reed canary grass		25	5		27	27	33.3		13	3		14	10	20
* side oats grama		10	10	35	53	40			5	5	17	28	15	
* switchgrass	75	95	100	100	53	53	60	40	46	54	48	28	20	36
Average % cover	91	73	71	87	27	71	57							
Robel (decimeters)		4.1	3.1	4.3	1	3.7	5.5							

	Dominance						Relative Dominance						Importance Value					
	9/1991	8/1992	8/1993	8/1994	8/1995	8/1999	9/1991	8/1992	8/1993	8/1994	8/1995	8/1999	9/1991	8/1992	8/1993	8/1994	8/1995	8/1999
alfalfa					1						1						2	
barnyard grass					3						5						4	
burnweed					0.2						0.3						1	
* Canada wild rye																		
clover					0.2						0.3						1	
dandelion	0.3						0.3						1					
dock	0.3						0.3						1					
evening primrose					1						1						3	
foxtail					3	0.3					4	0.6					6	2.3
lambsquarters					1						1						2	
marestail						2.3						4						8
* perennial rye	11						15						23					
Poa sp.		11	22	4	30	9.3		16	25	14	42	16.2		27	30	22	36	22.1
reed canary grass	11	0.5		10	13	12	15	0.7		34	18	20.8	14	2		24	14	20.4
* side oats grama	1	0.8	3	5	8		1	1	3	18	11		3	3	10	23	13	
* switchgrass	50	59	62	10	12	33.7	68	82	72	34	16	58.4	57	68	60	31	18	47.2

Onalaska Islands - Arrowhead

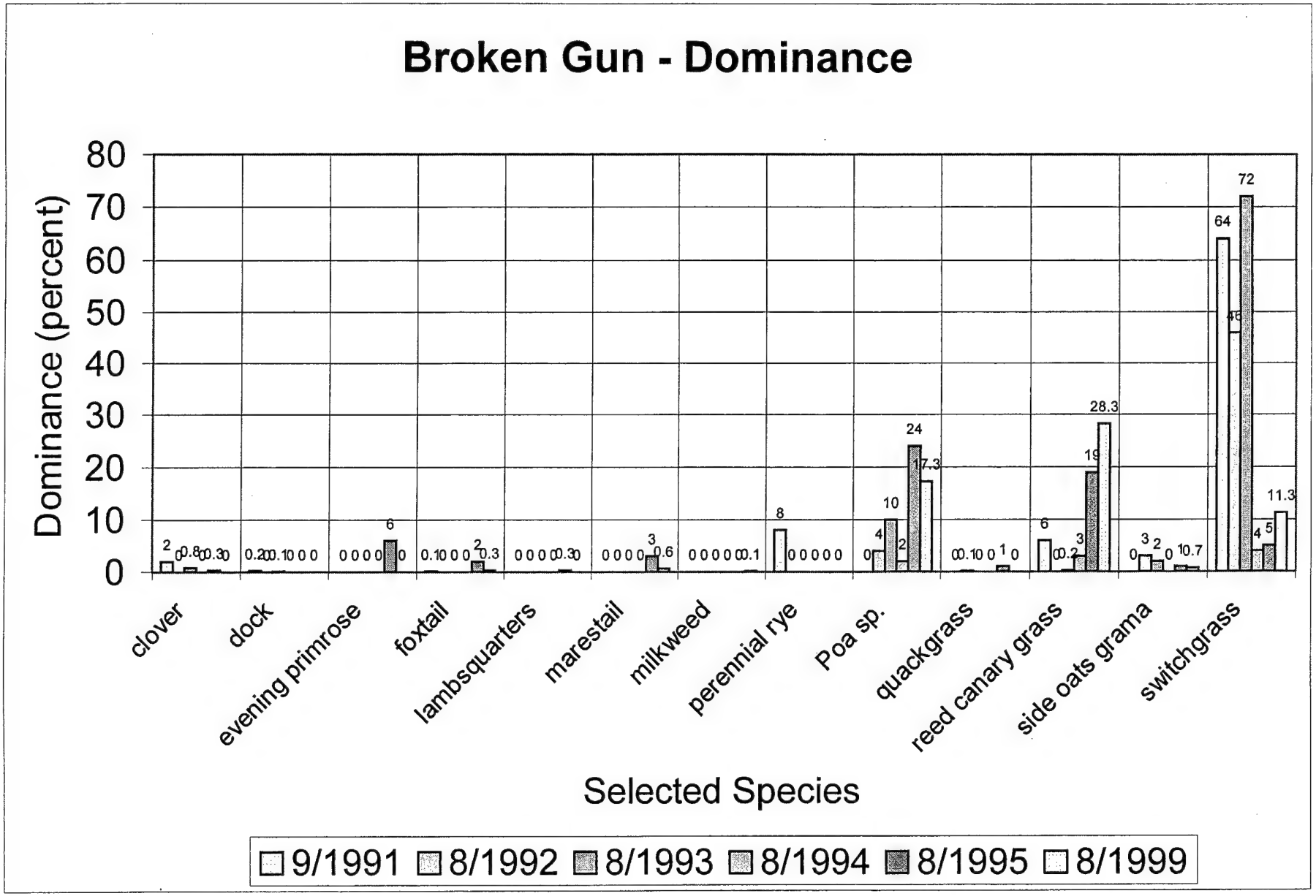
	Frequency							Relative Frequency						
	9/1990	9/1991	8/1992	8/1993	8/1994	8/1995	8/1999	9/1990	9/1991	8/1992	8/1993	8/1994	8/1995	8/1999
alfalfa			5							2				
* Canada wild rye														
foxtail		5							2					
evening primrose							13.3							5.3
* perennial rye	100	100	5					66	35	2				
Poa sp.			65	70	87	100	100			27	27	32	38	39.5
quackgrass			5				6.7			2				2.6
reed canary grass			5							2				
* side oats grama	2	80	55	90	87	60	33.5	2	28	23	35	32	23	13.2
* switchgrass	50	100	100	100	100	100	100	33	35	42	38	37	38	39.5
Average % cover	89	78	55	71	60	65	62							
Robel (decimeters)		2.1	2.1	2.8	3.4	3.5	1.8							

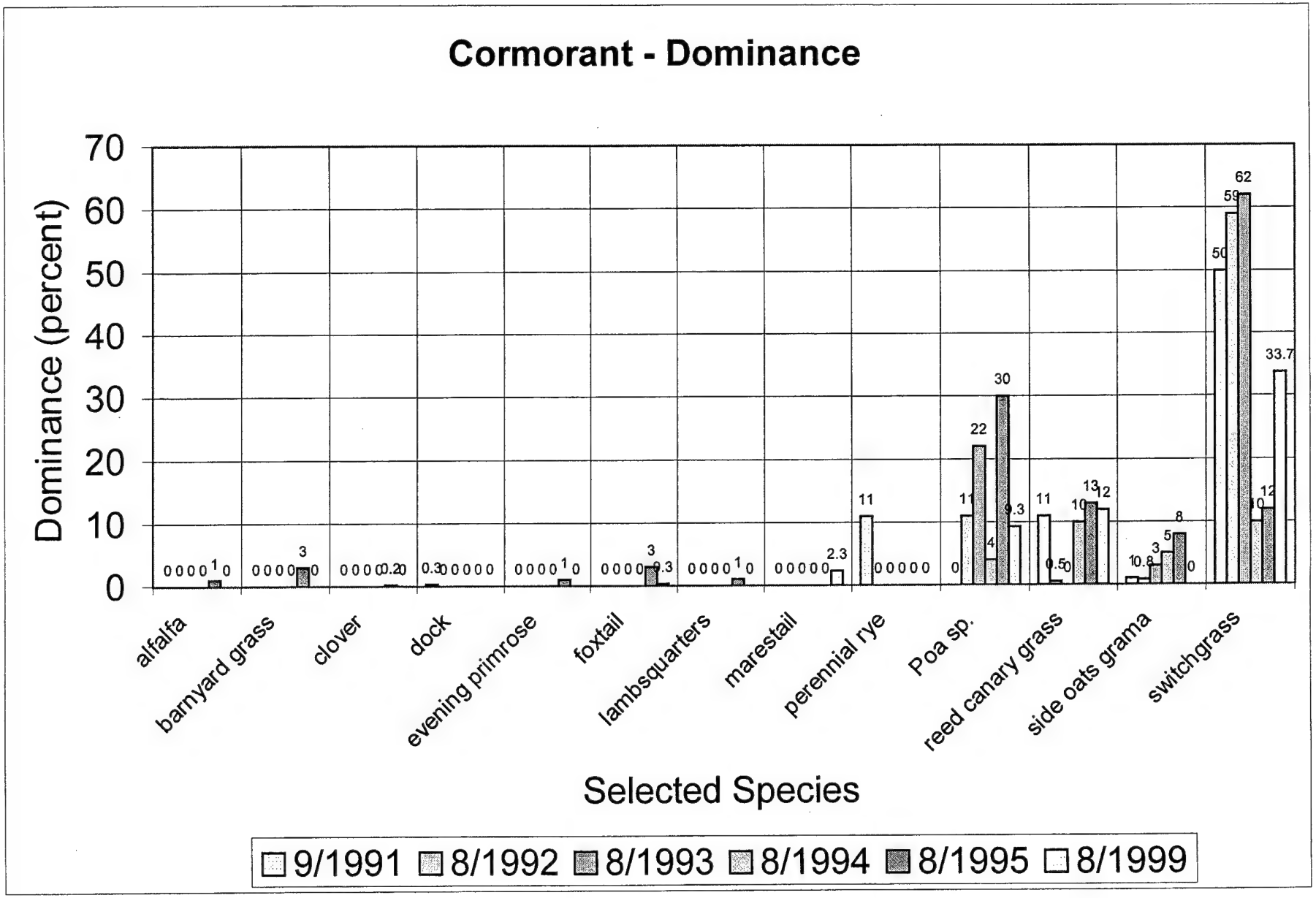
	Dominance						Relative Dominance						Importance Value					
	9/1991	8/1992	8/1993	8/1994	8/1995	8/1999	9/1991	8/1992	8/1993	8/1994	8/1995	8/1999	9/1991	8/1992	8/1993	8/1994	8/1995	8/1999
alfalfa		0.5						1						1				
* Canada wild rye																		
foxtail						1						1.6						3.4
evening primrose	0.2						0.3						1					
* perennial rye	24	0.1					31	0.1					33	1				
Poa sp.		8	6	7	23	33.3		15	9	12	35	54		21	18	22	37	46.8
quackgrass						0.3						0.5		1				1.6
reed canary grass		0.2						0.4						1				
* side oats grama	11	6	14	7	7	3	14	11	20	11	11	4.9	21	17	27	22	17	9
* switchgrass	43	40	51	47	35	24	55	72	71	77	54	38.9	45	57	55	57	46	39.2

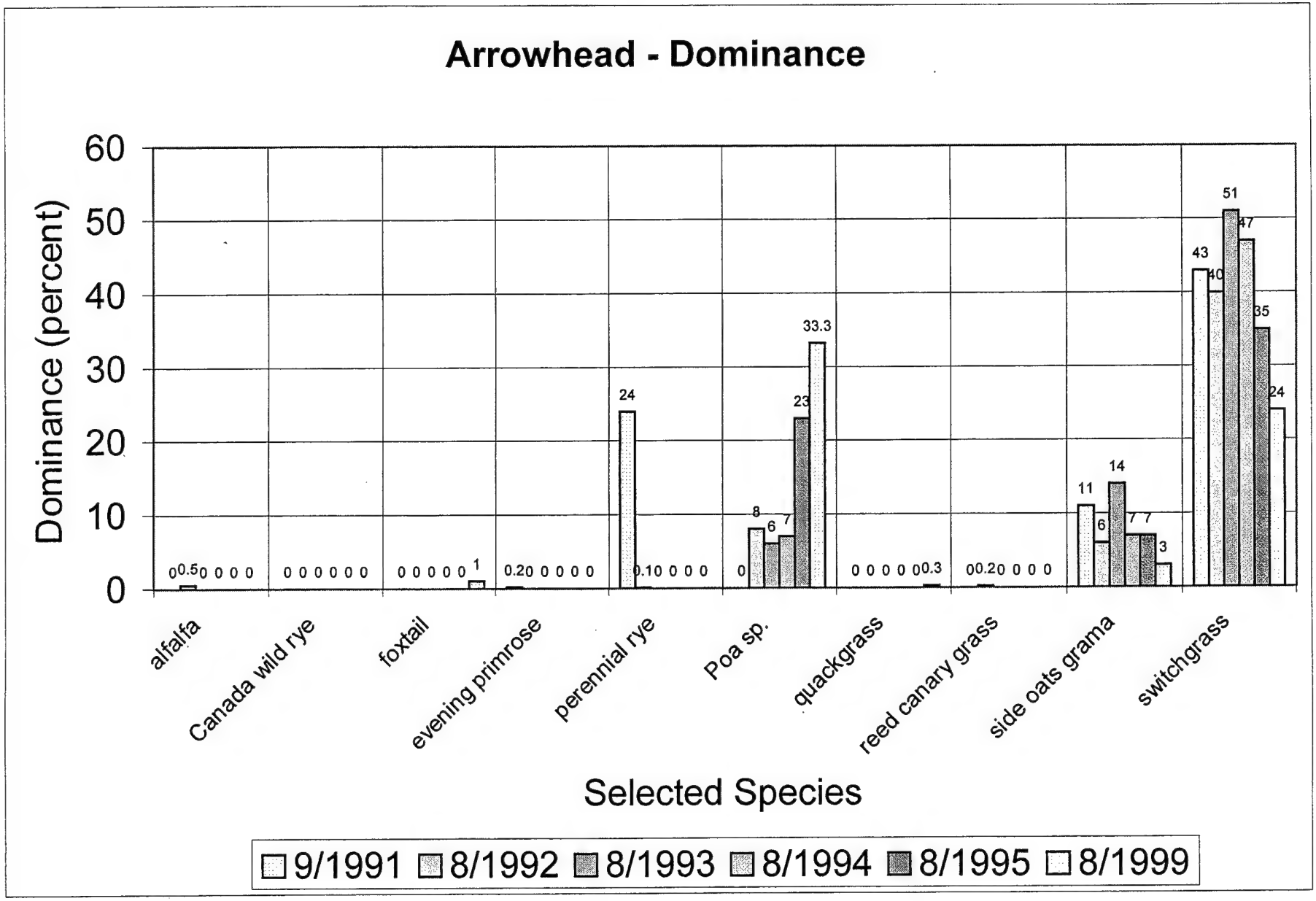
Onalaska Islands - Rosebud

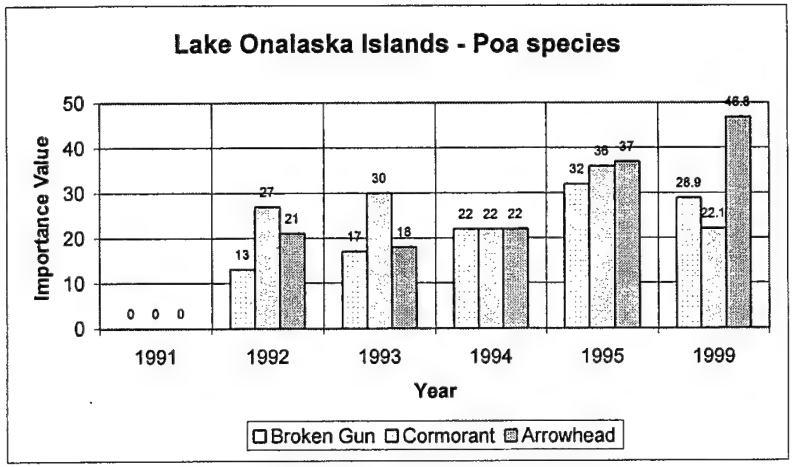
	Frequency							Relative Frequency						
	9/1990	9/1991	8/1992	8/1993	8/1994	8/1995	8/1999	9/1990	9/1991	8/1992	8/1993	8/1994	8/1995	8/1999
* annual rye														
* brome							60							33.3
crown vetch							100							55.6
* perennial rye														
* switchgrass							20							11.1
Average % cover		90					87							
Robel (decimeters)		3.5					2.2							

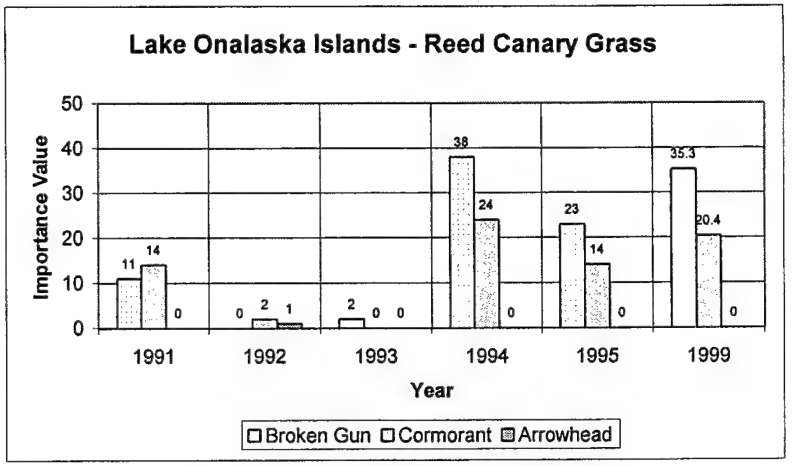
	Dominance						Relative Dominance						Importance Value					
	9/1991	8/1992	8/1993	8/1994	8/1995	8/1999	9/1991	8/1992	8/1993	8/1994	8/1995	8/1999	9/1991	8/1992	8/1993	8/1994	8/1995	8/1999
* annual rye																		
* brome						17.5						20.1						26.7
crown vetch						67.5						77.6						66.6
* perennial rye																		
* switchgrass						2						2.3						6.7

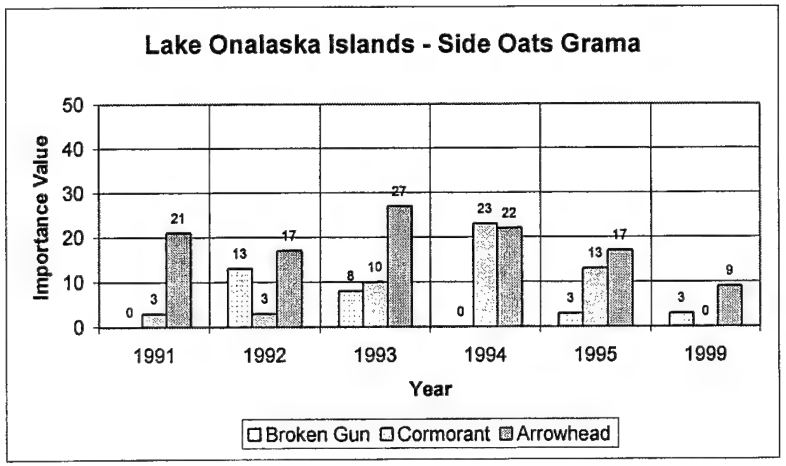

Broken Gun - Dominance
Dominance (percent)
80
70
60
50
40
30
20
10
0
clover
dock
evening primrose
foxtail
lambsquarters
marestail
milkweed
perennial rye
Poa sp.
quackgrass
reed canary grass
side oats grama
switchgrass
Selected Species
9/1991
8/1992
8/1993
8/1994
8/1995
8/1999

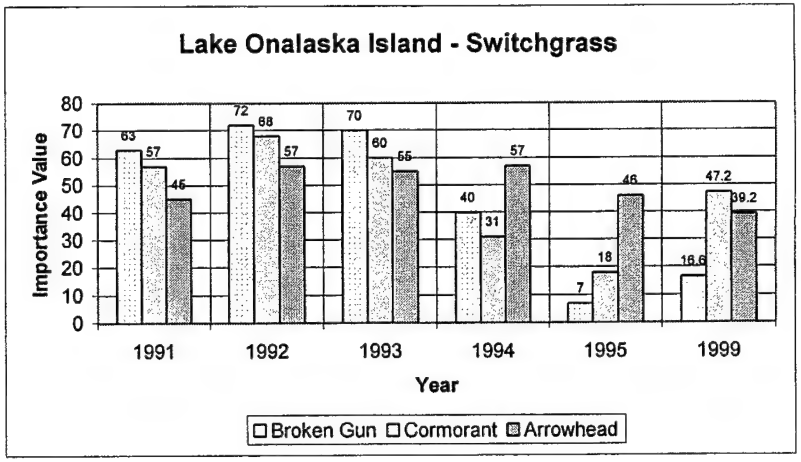

Cormorant - Dominance
Dominance (percent)
70
60
50
40
30
20
10
0
alfalfa
barnyard grass
clover
dock
evening primrose
foxtail
lambsquarters
marestail
perennial rye
Poa sp.
reed canary grass
side oats grama
switchgrass
Selected Species
9/1991
8/1992
8/1993
8/1994
8/1995
8/1999


Arrowhead - Dominance
Dominance (percent)
60
50
40
30
20
10
0
0 0.5 0 0 0 0
0 0 0 0 0 0
0 0 0 0 0 1
0.2 0 0 0 0 0
24 0.1 0 0 0 0
0 8 6 7 23 33.3
0 0 0 0 0 0.3
0 0.2 0 0 0 0
11 6 14 7 7 3
43 40 51 47 35 24
alfalfa
Canada wild rye
foxtail
evening primrose
perennial rye
Poa sp.
quackgrass
reed canary grass
side oats grama
switchgrass
Selected Species
9/1991
8/1992
8/1993
8/1994
8/1995
8/1999









Lake Onalaska Islands. Comparison of Importance Value for selected species from 1991 to 1999. Broken Gun and Cormorant Islands were burned in the fall of 1994 after sampling.

SUMMARY TABLE OF BURNED AND UNBURNED ONALASKA ISLANDS SURVEY DATA

	Frequency 8/1995	Relative Frequency 8/1995	Dominance 8/1995	Relative Dominance 8/1995	Importance Value 8/1995
* seeded species					
Onalaska Islands-Broken Gun - BURNED					
*Canada wild rye					
clover	12	5	0.6	0.8	3
evening primrose	38	16	12	17	16
foxtail	25	11	4	5	8
lambsquarters	12	5	0.6	0.8	3
marestail	25	11	2	3	7
*perennial rye					
Poa sp.	50	21	19	23	22
quackgrass	25	11	2	3	7
reed canary grass	50	21	34	47	34
*side oats grama					
*switchgrass					
Average % cover	71				
Robel (decimeters)	5.8				
Onalaska Islands-Broken Gun - NOT BURNED					
burnweed	25	8	4	8	8
*Canada wild rye					
daisy fleabane	12	4	2	3	4
foxtail	12	4	0.2	0.4	2
marestail	50	16	4	6	11
*perennial rye					
Poa sp.	100	32	30	52	42
quackgrass	12	4	0.6	1	3
reed canary grass	38	12	4	8	10
*side oats grama	25	8	2	3	6
*switchgrass	38	12	11	18	15
Average % cover	58				
Robel (decimeters)	1.6				
Onalaska Islands-Cormorant - BURNED					
alfalfa	17	8	2	2	5
barnyard grass	17	8	8	9	8
*Canada wild rye					
clover	17	8	0.5	0.6	4
foxtail	17	8	7	7	8
lambsquarters	17	8	2	3	5
*perennial rye					
Poa sp.	83	38	49	54	46
reed canary grass	33	15	18	20	18
*side oats grama					
*switchgrass	17	8	4	5	6
Average % cover	89				
Robel (decimeters)	3.2				
Onalaska Islands-Cormorant - NOT BURNED					
burnweed	11	4	0.3	0.6	2
*Canada wild rye					
evening primrose	22	7	2	3	5
foxtail	22	7	0.7	1	4
*perennial rye					
Poa sp.	78	26	18	30	28
reed canary grass	22	7	9	16	12
*side oats grama	67	22	13	22	22
*switchgrass	78	26	17	28	27
Average % cover	59				
Robel (decimeters)	1.7				

SUMMARY TABLE OF BURNED AND UNBURNED ONALASKA ISLANDS SURVEY DATA

* seeded species

Bold and italics indicates species recorded on burned areas

	Frequency 8/1995	Relative Frequency 8/1995	Dominance 8/1995	Relative Dominance 8/1995	Importance Value 8/1995
Onalaska Islands-Broken Gun					
burnweed	25	8	4	8	8
****Canada wild rye***					
*Canada wild rye					
clover	***12***	***5***	***0.6***	***0.8***	***3***
daisy fleabane	12	4	2	3	4
evening primrose	***38***	***16***	***12***	***17***	***16***
foxtail	***25***	***11***	***4***	***5***	***8***
foxtail	12	4	0.2	0.4	2
lambsquarters	***12***	***5***	***0.6***	***0.8***	***3***
marestail	50	16	4	6	11
marestail	***25***	***11***	***2***	***3***	***7***
*perennial rye					
****perennial rye***					
Poa sp.	100	32	30	52	42
Poa sp.	***50***	***21***	***19***	***23***	***22***
quackgrass	12	4	0.6	1	3
quackgrass	***25***	***11***	***2***	***3***	***7***
reed canary grass	38	12	4	8	10
reed canary grass	***50***	***21***	***34***	***47***	***34***
*side oats grama	25	8	2	3	6
****side oats grama***					
****switchgrass***					
*switchgrass	38	12	11	18	15

Onalaska Islands-Cormorant					
alfalfa	***17***	***8***	***2***	***2***	***5***
barnyard grass	***17***	***8***	***8***	***9***	***8***
burnweed	11	4	0.3	0.6	2
*Canada wild rye					
****Canada wild rye***					
clover	***17***	***8***	***0.5***	***0.6***	***4***
evening primrose	22	7	2	3	5
foxtail	***17***	***8***	***7***	***7***	***8***
foxtail	22	7	0.7	1	4
lambsquarters	***17***	***8***	***2***	***3***	***5***
****perennial rye***					
*perennial rye					
Poa sp.	78	26	18	30	28
Poa sp.	***83***	***38***	***49***	***54***	***46***
reed canary grass	22	7	9	16	12
reed canary grass	***33***	***15***	***18***	***20***	***18***
*side oats grama	67	22	13	22	22
****side oats grama***					
****switchgrass***	***17***	***8***	***4***	***5***	***6***
*switchgrass	78	26	17	28	27

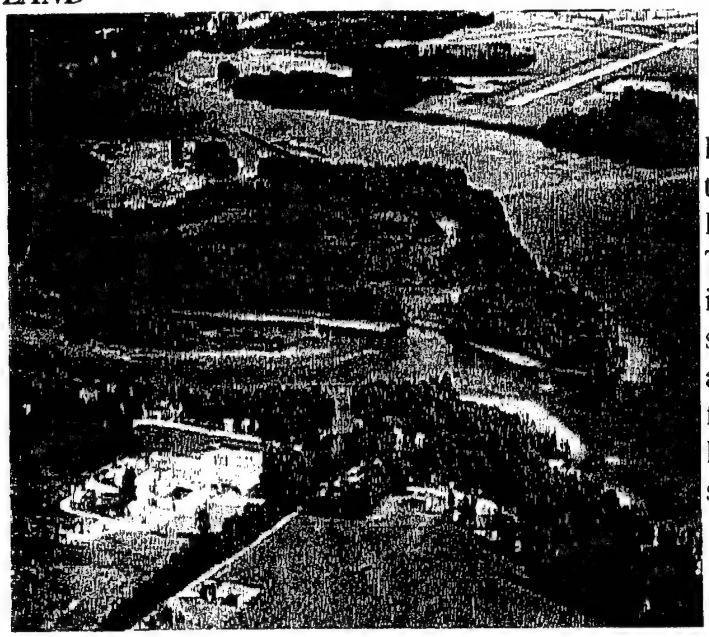
Rosebud Island, Pool 7, RM 705.0

Rosebud Island was part of the Lake Onalaska Islands HREP project in Pool 7 and was constructed in 1989. Although identified as a source of borrow material, it was never used for borrow. Rosebud Island was used as a placement area for fine sediments from channel dredging in Lake Onalaska. The placement site had a high concentration of fine sediment and was seeded in June 1990 at 25 lbs./ac. with the following seed mixture.

Species	Seeding Rate
switchgrass	combined
brome	mix of
perennial ryegrass	25 lbs./ac
annual rye	2 bushels/ac.

The placement site was monitored in September 1991 and August 1999. Total percent cover was 90% in 1991 and 87% in 1999. Robel readings were 3.5 and 2.2 decimeters in 1991 and 1999, respectively. On the basis of importance value, the dominant species found on the site in 1999 were crown vetch, brome and switchgrass. On the basis of 1999 observations, the site is well vegetated; crown vetch was expanding over the site and may limit the abundance of other species. See Figures 11 and 12 for graphical percent cover and Robel data and the summary table following the Lake Onalaska section for tabular data.

ROSEBUD ISLAND



Rosebud Island was part of the Lake Onalaska Islands HREP project in Pool 7. The disposal site on the island contained fine sediments dredged from an adjacent backwater area for fishery enhancement. Dredged material was seeded to grasses in 1990.

Rosebud Island in August 1991 had 90% cover. Species observed included sweet clover, Canada wild rye, switchgrass, foxtail, and ragweed.

In 1999, percent cover on Rosebud Island was 87%. Important species were crown vetch, brome, and switchgrass. Crown vetch was expanding on the site.

Pool 8 Islands, Pool 8, RM 684.0 to RM 687.5

Vegetation Measures

Pool 8 Islands is an HREP project located in lower Pool 8. The project is being constructed in several phases. Phase 1 of the project involved protecting existing islands and constructing new islands downstream of Brownsville, Minnesota. During Phase 1 of the project, Horseshoe Island was capped with fine sediment and seeded in June 1991. Boomerang Island was constructed with sand, capped with fine material, and seeded in June 1993. Both areas were drill seeded with the following mixture and mulched.

Species	Seeding Rate
Canada wild rye	5 lbs. PLS/ac.
thickspike wheatgrass	6 lbs. PLS/ac.
side oats grama	3 lbs. PLS/ac.
switchgrass	5 lbs. PLS/ac.
perennial ryegrass	10 lbs./ac.

Willow cuttings were placed along the shoreline on both sides of Boomerang Island in all areas that were not riprapped at the time of initial seeding. Cottonwood was planted on the top of the islands in the spring of 1993. The willow plantings were included in the monitoring but the cottonwood was not.

Phase 2 of the project involved reconstructing islands within an area known as Stoddard Bay near Stoddard, Wisconsin. Phase 2 islands (Islands A (Eagle), B (Slingshot), C (Slingshot), D1 (Slingshot), D2 (Pasque), E1 (Greenwing), and E2 (Sunfish)) were completed in 1999. Various seed mixtures and combinations of willow, beachgrass, forbs, shrubs, and trees were used to revegetate the constructed islands.

The various seed mixtures used were as follows:

Seed Mix 1

Species	Seeding Rate
alfalfa	6 lbs./ac.
smooth brome grass	6 lbs./ac.
timothy	4 lbs./ac.
oats	20 lbs./ac.

Seed Mix 2

Species	Seeding Rate
switchgrass	3 lbs. PLS/ac.
Canada wild rye	3 lbs. PLS/ac.
side oats grama	2 lbs. PLS/ac.
sand bluestem	1 lb. PLS/ac.
sand dropseed	1 lb. PLS/ac.
oats	20 lbs./ac.
Wildflower Species	Seeding Rate
prairie clovers	1 oz./ac.
partridge pea	1 oz./ac.
Maximilian sunflower	1 oz./ac.

Seed Mix 3

Species	Seeding Rate
Virginia wild rye	6 lbs./ac.
switchgrass	2 lbs. PLS/ac.
Indian grass	1 lb. PLS/ac.
big bluestem	1 lb. PLS/ac.
prairie cordgrass	0.2 lb. PLS/ac.
bluejoint reedgrass	0.1 lb. PLS/ac.
oats	20 lbs./ac.
Wildflower Species	Seeding Rate
black-eyed Susan	2 oz./ac.

Seed Mix 4

Species	Seeding Rate
Canada wild rye	5 lbs. PLS/ac.
little bluestem	3 lbs. PLS/ac.
sand dropseed	1 lb. PLS/ac.
side oats grama	1 lb. PLS/ac.
oats	20 lbs./ac.
Wildflower Species	Seeding Rate
prairie clover	3 oz./ac.
partridge pea	2 oz./ac.
Maximilian sunflower	1 oz./ac.

Phase 2 islands were seeded/planted in 1999 as follows:

Island	Seed Mix	Seeded	Willows	Beachgrass	Bushes	Trees
A	1	30 June	13-15 July	NA	13-15 July	13-15 July
B	2	4 May	5 May	NA	5 May	NA
C	3	18 June	22 June	NA	NA	NA
D1	1	4 May	6 May	6 May	NA	6 May
D2	4	29 June	13-15 July	13-15 July	NA	NA
E1	4	19 May	23 June	23 June	NA	NA
E2	4	29 June	13-15 July	13-15 July	NA	NA

Monitoring Results

Phase 1. In August 1992, 30 plots were randomly selected on Horseshoe Island, 15 to the east of the center of the island and 15 to the west. The purpose was to test for a difference between the east and west sides of the island. Based on the results of monitoring in 1991 and 1992, there did not appear to be a significant difference between the two sides. Starting in 1993, monitoring did not differentiate between these areas and 15 plots were taken on Horseshoe Island. Thirty plots were taken on Boomerang Island and were located at midpoints between steel fence posts that follow the length of the island.

The summer (July) flood of 1993 inundated Boomerang Island entirely for varying durations. The top of the island was inundated by about 6 inches of water. The seeded areas looked to be growing very well considering the flooding. In 1995, a Robel reading of 5.2 decimeters was recorded for Horseshoe Island. This represents an increase of about 2.3 decimeters from the previous year. The Robel reading for Boomerang Island was 4.8 decimeters, which is an increase of 2.6 decimeters from the previous year. A Robel reading of zero was obtained in 1993 for Boomerang Island. See Figure 13 for a summary of the Robel readings.

By 1999, Horseshoe and Boomerang Islands had become a dense stand of woody vegetation and herbs. The Robel pole is intended to be used with grass vegetation; therefore, Robel readings were not taken in 1999. The vegetation on Boomerang Island was a dense stand of 10- to 12-foot willow, cottonwood, and false indigo and 4- to 5-foot herbs. Horseshoe Island was similar, but not as dense. There is still a small area of open grassland in the center of the island. No plots were taken on either of these two islands in 1999, but a list of observed species was prepared.

Total percent cover was estimated on each of the quarter-square-meter plots. The cover percentages are presented below and on Figure 14.

	Percent Cover (date)				
Area	9/1991	8/1992	8/1993	8/1994	8/1995
Horseshoe Island					
East Side	34	78	66	51	61
West Side	46	70			
Boomerang Island			26	62	55

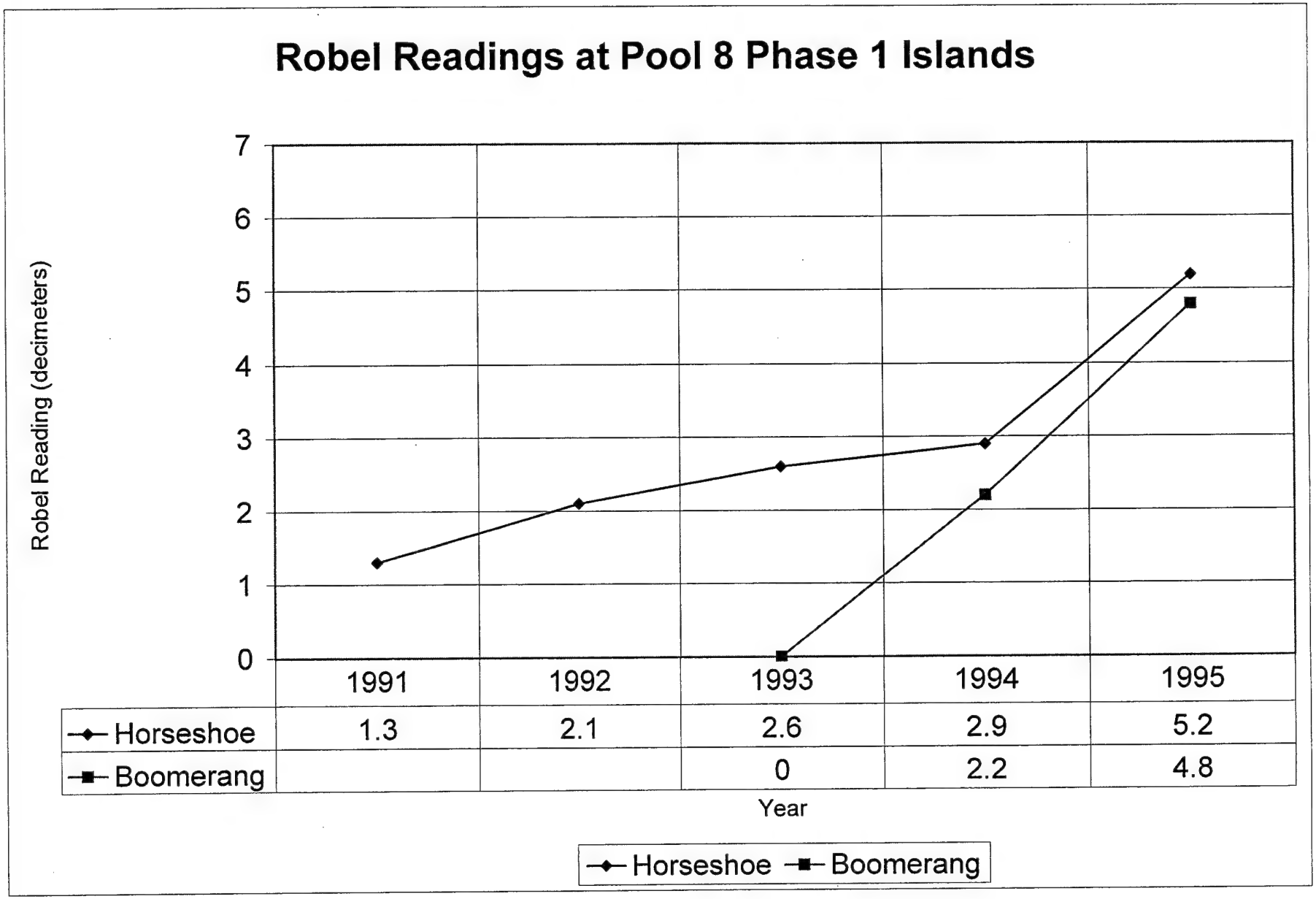


Figure 13. Robel readings for Pool 8 Phase 1 Islands HREP project.

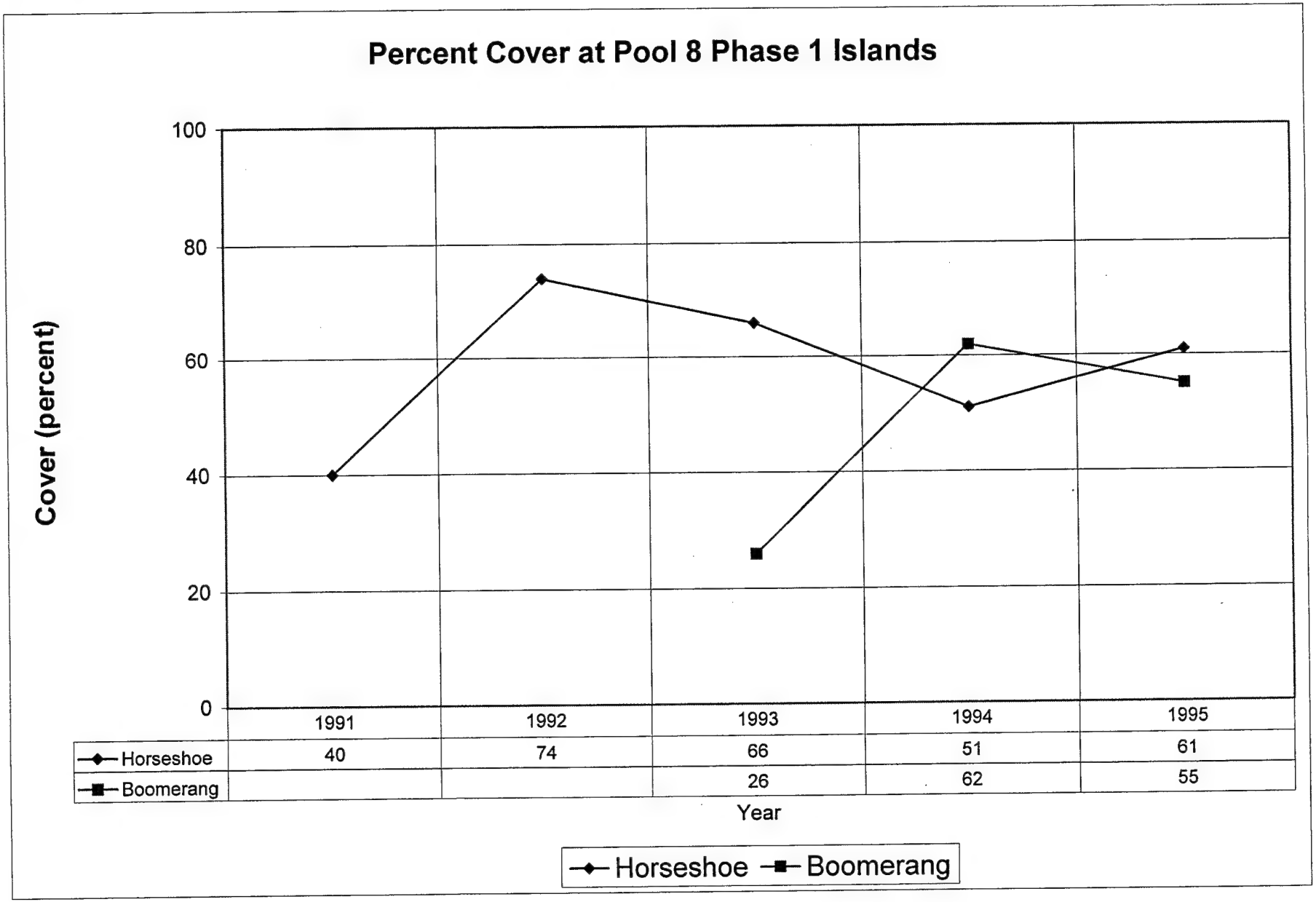


Figure 14. Percent cover estimates for Pool 8 Islands Phase 1.

An Analysis of Variance (ANOVA) was performed on percent cover estimates. There was no difference between the east and west sides of Horseshoe Island in either 1991 or 1992. However, an ANOVA test showed that there was a significant difference in percent cover at the 0.01 level between 1991 and 1992 for Horseshoe Island, and between Horseshoe Island and Boomerang Island in 1993. There was also a significant difference in percent cover between 1993 and 1994 on both Horseshoe and Boomerang Islands.

The percent cover was also estimated for each species on the plot. The frequency, relative frequency, dominance, relative dominance, and importance value were also calculated for each species. There was a major decrease in the importance of weedy species in 1992. This trend continued in 1993 and to a lesser degree in 1994 and 1995. Species such as barnyard grass, smartweed, velvet leaf, and clammyweed have disappeared. Reed canary grass, switchgrass, side oats grama, and Canada wild rye are the dominant species on the sample plots. Purple loosestrife is common on Boomerang Island. Horseshoe and Boomerang Islands have become dominated by tall woody and herbaceous vegetation. Some weed species were present on the islands during the early years but are not dominant.

On the basis of importance value, the three most important species found on the Phase 1 islands were:

	Year		
	1993	1994	1995
Horseshoe Island	switchgrass	reed canary grass	Canada wild rye
	reed canary grass	switchgrass	switchgrass
	side oats grama	side oats grama	reed canary grass
Boomerang Island	perennial rye	Canada wild rye	Canada wild rye
	smartweed	perennial rye	switchgrass
	reed canary grass	purple loosestrife & switchgrass	purple loosestrife

The Jaccard Index of Species Similarity was calculated for Horseshoe and Boomerang Islands. The index is based on the number of species common to both areas. Only the species recorded on the sample plots are used for this calculation. Between 1993 and 1995, Horseshoe Island had an index of 50 (50% of the species in common), whereas Boomerang Island had an index of 12 for the same period. This indicates there was a large change in vegetation on Boomerang Island during that period.

Willow cuttings were monitored at two areas on Boomerang Island during the early years of establishment, and most of the island was visually inspected. The 1993 results included the following: at the north end of Boomerang Island, one 200-foot-long area had 187 live willow out of 196; at the south end of Boomerang Island, a 200-foot-long area had 172 live willow out of 174. A visual inspection of other areas seemed to show similar results. The only area where the willow did not appear to be growing very well in 1993 was at about station 25 on the back side

of the island. The inside bend of the island showed many dead willow cuttings. This was only at the bend near station 25. In 1994 and 1995, willow was prolific. In many areas, it was so dense that cuttings could not be counted. In areas where the cuttings could be found, survival was very high. Both planted and natural willow reproduction was successful. There seemed to be more aquatic plants around the island in 1995 than in previous years. Water lily and lotus were common.

Soil samples were taken on the Phase 1 islands in 1994 to determine the percent of fine material present. Results were as follows:

Horseshoe Island, dense vegetative cover:	42.4% fine material
Boomerang Island, light vegetative cover:	29.1% fine material
Boomerang Island, dense vegetative cover:	43.9% fine material

At that time, it appeared that the denser growth of vegetation is found in areas with more fine material. This relationship does not hold for other areas that were sampled. It may be worthwhile to reduce the amount of fine material in future projects.

Phase 2. Starting in August 1999, plots were taken on some of the Phase 2 islands also. Plots were not taken on Islands A or D1 because trees were planted on these islands to become the long-term vegetative cover. Islands C and D2 were not sampled in 1999 because they were recently planted and had little vegetative cover present at the time of monitoring. On each of the plots, percent cover was estimated for the entire plot and for individual species. In addition, Robel readings were taken at each of the cover plots.

Initial observations were made on the Phase 2 islands in 1999 but are inconclusive at this early stage of development. Sample plots were taken on the Phase 2 Islands B, E1, and E2. Total percent cover, percent cover by species, and Robel readings were taken. Islands A and D1 were not sampled because the long-term vegetation goal is trees and not grassland vegetation. Islands C and D2 were also not monitored in 1999 because the cover was sparse and Robel readings would have been zero. The Robel reading on Island B was 6.8 decimeters. The Robel reading on the E islands was less than 1.5 decimeters. A list of vegetation observed while walking over Islands C and D2 was made. The willow cuttings were growing on Island C but were not doing as well on Island D2. The vegetation was less dense on the west side of the sand hill on Island D2. The beachgrass looked dead on top. There were few live stolons.

In August 2000, Robel readings on Islands A, B, C, D1, D2, E1, and E2 all ranged between 1 and 4, with the highest reading on Island C. See Figure 15 for a comparison of Robel readings among the islands for 1999 and 2000.

In 1999, percent cover was as follows: Island B 89%, Island E1 36%, Island E2 28%. An Analysis of Variance was performed on the percent cover. In 1999, there was a significant difference in cover between Islands E1 and E2 and Island B, but not between Islands E1 and E2. In August 2000, percent cover ranged between 30 and 60 percent for the Phase 2 islands. See Figure 16 for a graphical presentation of percent cover estimates for the Phase 2 islands.

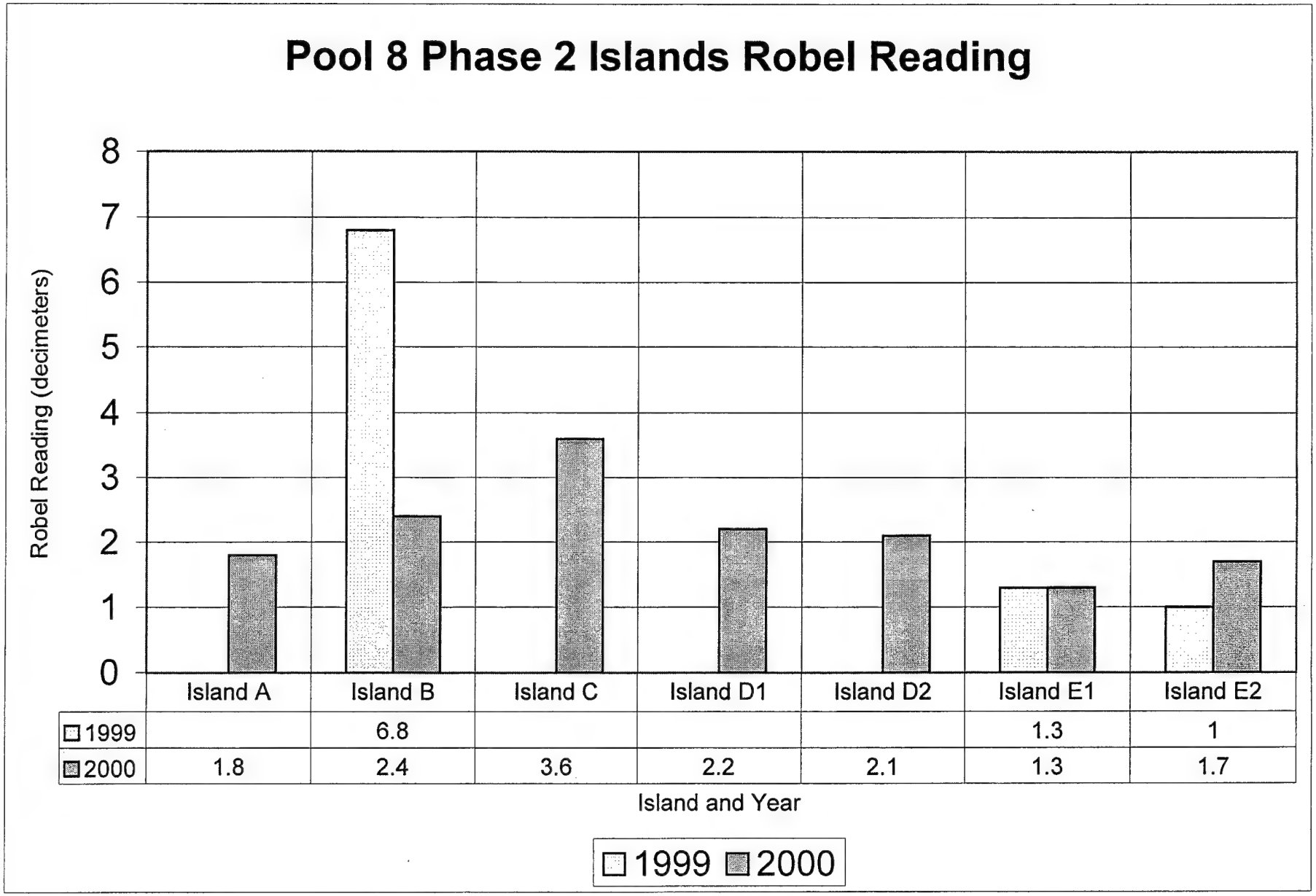


Figure 15. Robel readings for Pool 8 Phase 2 Islands HREP project.

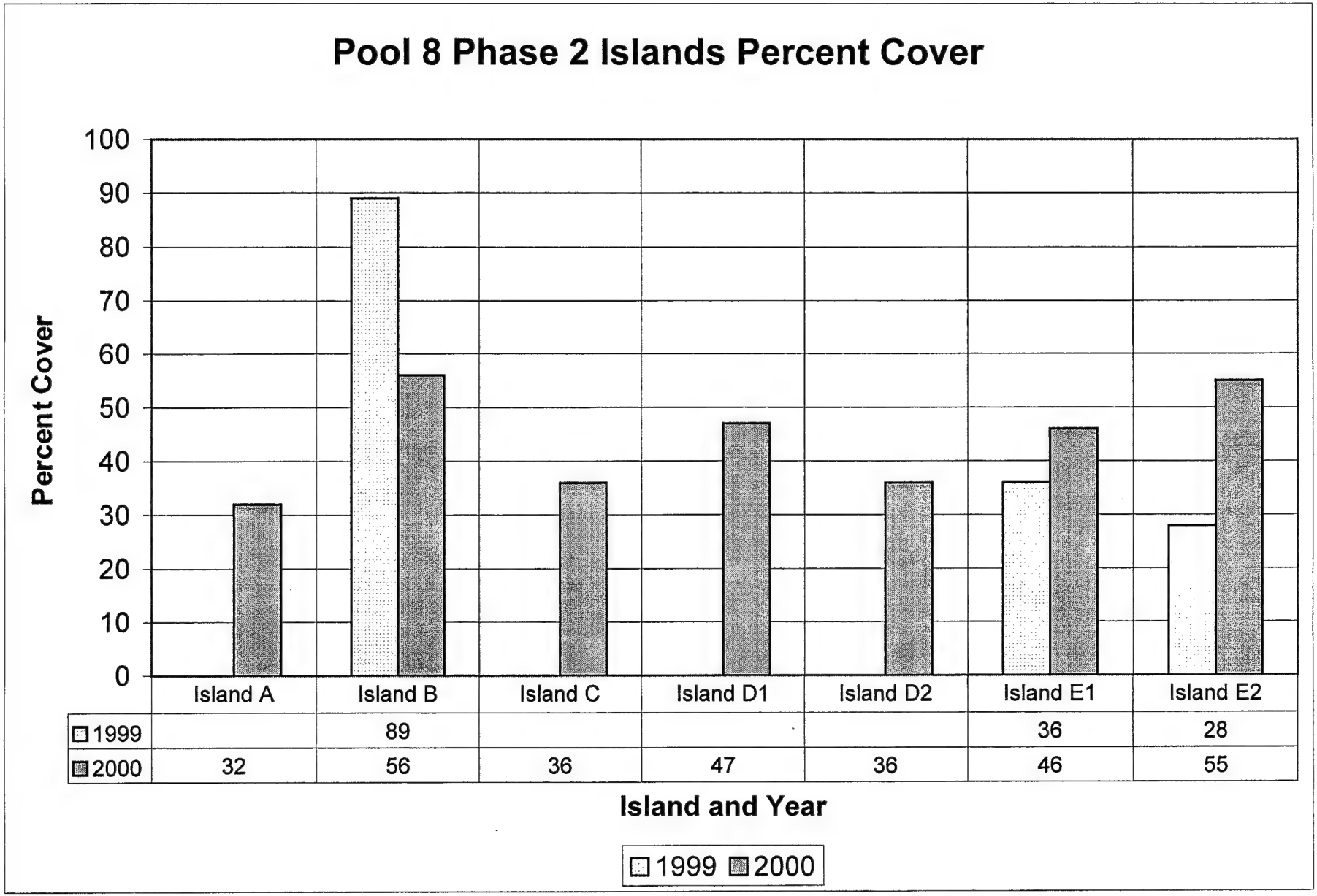


Figure 16. Percent cover estimates for Pool 8 Islands Phase 2 HREP project.

On the basis of importance value, the three most important species found on the Phase 2 islands in 1999 and 2000 were:

Island	Year	
	1999	2000
Island A		alfalfa
		brome
		Virginia wild rye
Island B	foxtail	Muhlenbergia
	Muhlenbergia	foxtail
	Canada wild rye	switchgrass
Island C		Canada wild rye
		black-eyed Susan
		Virginia wild rye
Island D1		alfalfa
		brome
		Canada wild rye
Island D2		Canada wild rye
		side oats grama
		Virginia wild rye
Island E1	foxtail	foxtail
	Muhlenbergia	Canada wild rye
	oats	black-eyed Susan
Island E2	foxtail	foxtail
	oats	Canada wild rye
	Muhlenbergia	side oats grama

There were a number of "weedy" species on the islands, including purple loosestrife. Foxtail was dominant the first year at some other HREP projects, Peterson and Polander Lakes, but declined in subsequent years and was replaced with the seeded species. Future monitoring will be needed to determine if this occurs at the Pool 8 Phase 2 islands.

The Jaccard Index of Species Similarity was calculated for Islands B, E1, and E2 in 1999. Islands E1 and E2 have over half of their species in common. Island B has about 30% of its species in common with Islands E1 and E2.

In August 2000, observations were also made on the beachgrass, tree, and willow plantings on the islands. The descriptions are based on casual observations while conducting the grass monitoring survey plots.

On Island A, tree survival was about 50 percent. Survival appeared to be higher for trees planted with mats and with both mats and tubes. The island had a dense growth of alfalfa, much of which was dried up. Many voles (*Microtus pennsylvanicus*) were seen while conducting the survey. The alfalfa may have provided good habitat for voles that subsequently girdled many trees. Willow cuttings were growing but with some sparse areas. The willow cuttings on Island B appeared to be doing well. There was a fair amount of dead foxtail from last year's growth. The willow cuttings along the entire shoreline of Island C looked good.

The trees on Island D1 exhibited about 75 percent survival. Many voles were observed at the site. The willow cutting survival rate appeared to be good. The beachgrass plantings in the middle and east end of the island were sparse but growing. The willow cuttings on Island D2 showed about 50 percent survival with some sparse areas. The beachgrass plantings looked good and were expanding. The sand areas have some smartweed, Canada wild rye, and foxtail growing with the beachgrass.

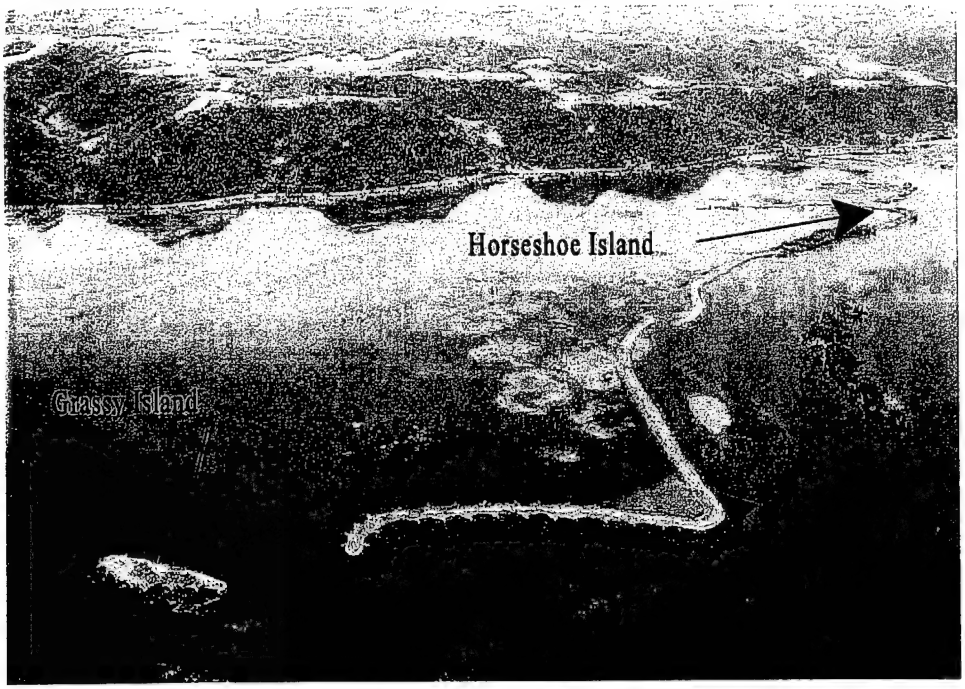
The willow cuttings on the north shore of Island E1 looked good. About half of the cuttings sprouted on the south shore. The beachgrass plantings were expanding, with only a small amount of smartweed on the site. The willow cuttings on Island E2 looked good, with some dead areas in the center on both the north and south shores. The beachgrass plantings were growing well, with some marestail, smartweed, and Canada wild rye on the site.

Summary

The seeded (grass) areas on the Phase 1 islands have been replaced by dense woody and herbaceous vegetation. Phase 2 islands were planted in 1999; it was too early to draw many conclusions from the monitoring. However, it appeared that the seeding and willow plantings were successful. Observations by the La Crosse Office of the U.S. Fish and Wildlife Service in March 2000 indicated that many of the willow and trees on Islands A, B, and D1 were girdled by small mammals. This trend continued to August. At least half of the trees survived, and the willow appeared to be doing well in most locations. In 1999, the beachgrass stolons appeared to be in good condition in some areas but dead in others; time will tell if their roots have survived. Beachgrass at most sites appeared to be in excellent condition in August 2000. Beachgrass stolons planted at the Crosby Island site in 1986 were thought to be dead at the initial observation, but survived and expanded their distribution.

The alfalfa on the tree islands produced a dense growth and may have provided good habitat for voles that girdled many trees. Side oats grama, Canada wild rye, Virginia wild rye, black-eyed Susan, sunflower, and brome were growing well after 2 years. Foxtail had declined the second year but was still present at some sites.

POOL 8 ISLANDS



Phase 1 of the Lower Pool 8 HREP project. Horseshoe and Boomerang Islands were constructed of sand, capped with fine sediments, and seeded with grasses.

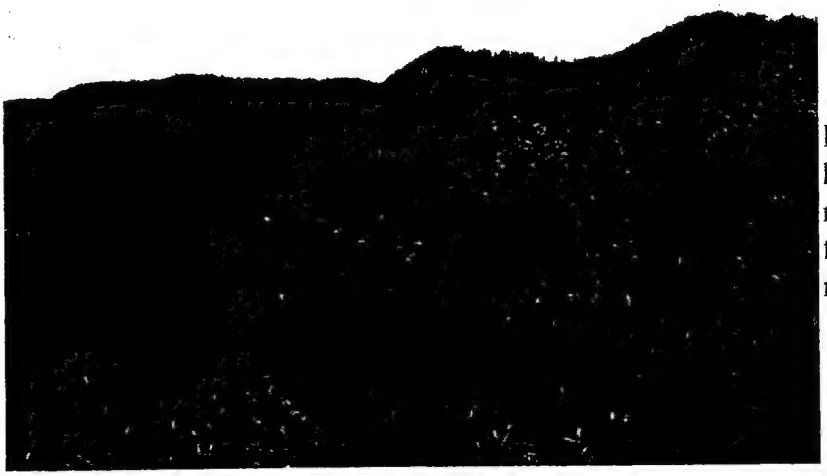
Horseshoe Island prior to seeding in August 1989. Horseshoe Island was an existing island that was restored in size and riprapped for protection on the upstream end. Sand dredged material was capped with fine sediments.

Horseshoe Island was seeded in June 1991. In August 1991, total cover was 40%. Dominant species were wild oats, switchgrass, side oats grama, and barnyard grass.

POOL 8 ISLANDS

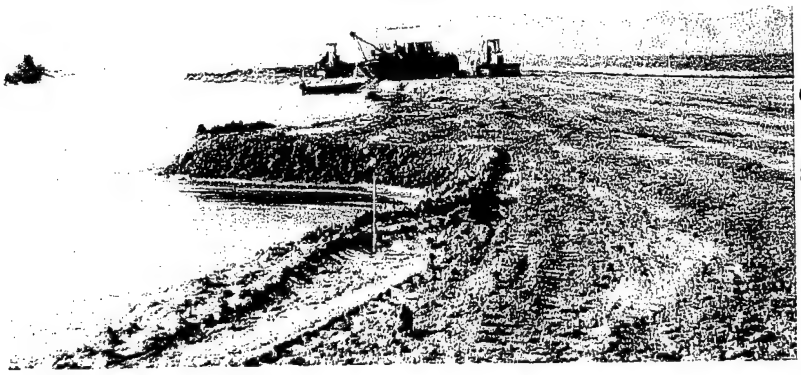
In August 1995, percent cover on Horseshoe Island was 61%. The dominant species were Canada wild rye, switchgrass, and reed canary grass.

East portion of Horseshoe Island in August 1995. Good growth of Canada wild rye and reed canary grass prior to being invaded by woody and herbaceous vegetation. Robel reading was 5.2 decimeters.

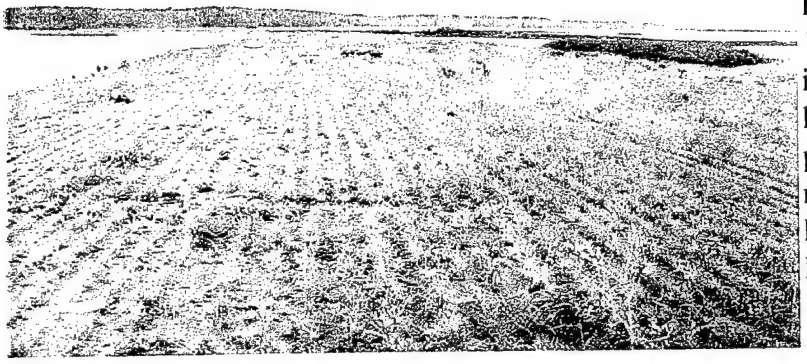


By 1999, trees and tall herbaceous species took over much of the island, although a few areas of dense grasses remained.

POOL 8 ISLANDS

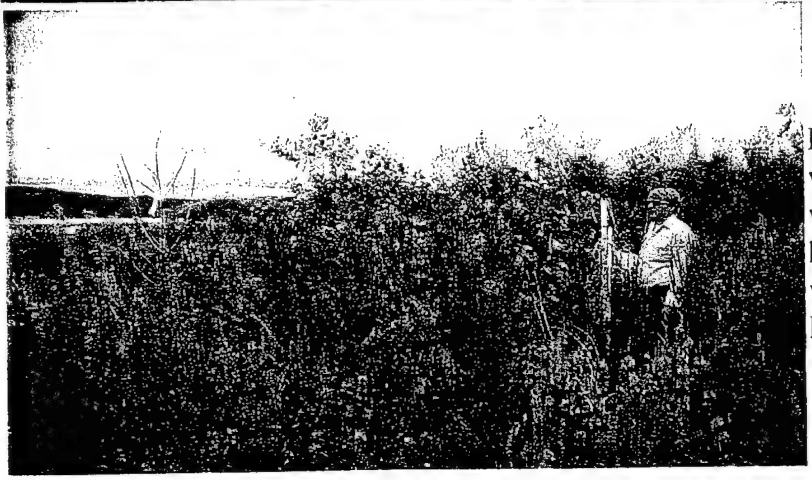


Construction of Boomerang Island in 1993. The island was constructed of sand, capped with fine sediment, and planted with grasses and trees.

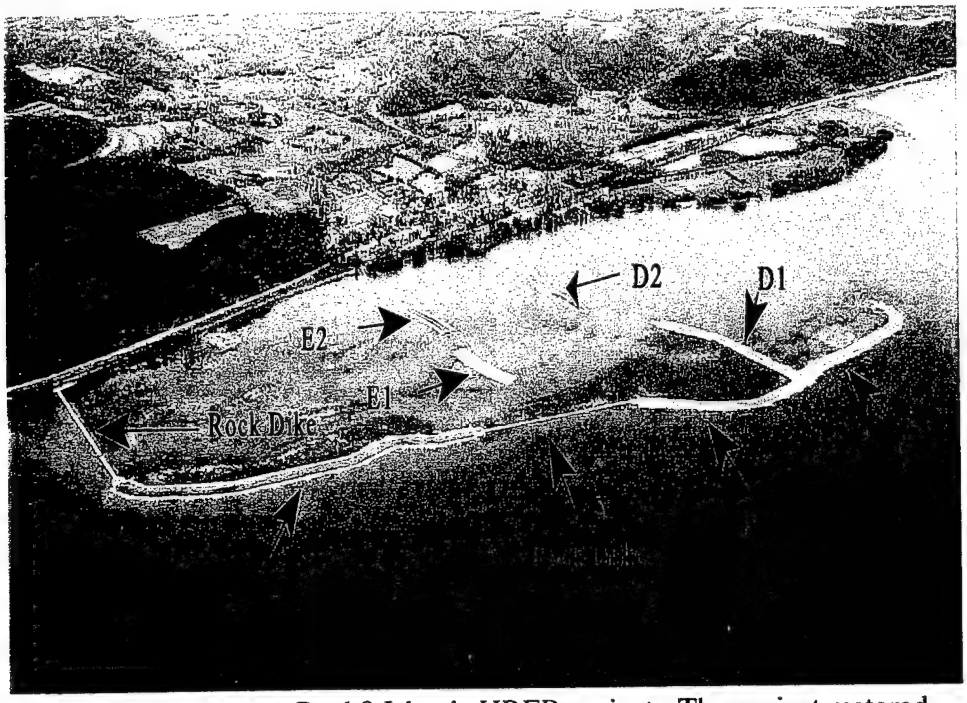


Boomerang Island was seeded in June 1993. The flood of June 15, 1993 inundated most of the island by at least 6 inches. This August 1993 photo shows that two months later much of the vegetation survived. Percent cover averaged 26% with a Robel reading of zero.

In August 1994, Boomerang Island had 62% cover and a Robel reading of 2.2 decimeters. Dominant species were Canada wild rye, switchgrass, and purple loosestrife. Willow cuttings along the shoreline had excellent survival.

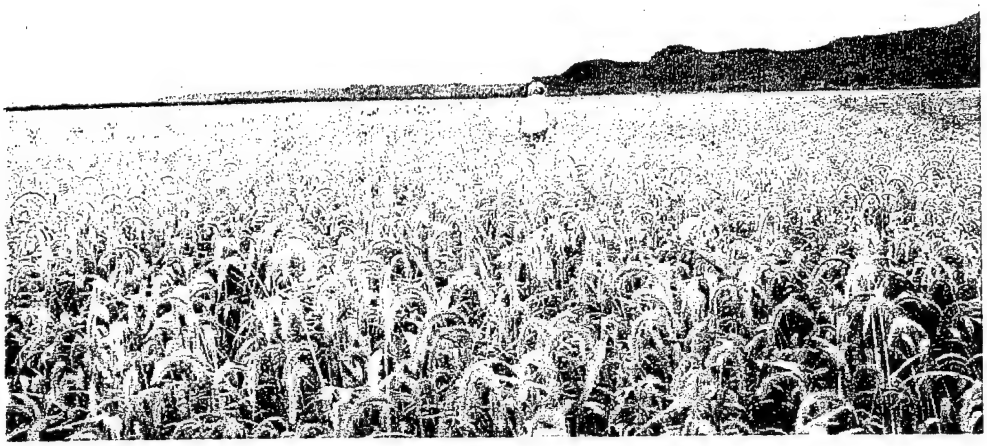


By August 1999, Boomerang Island was taken over almost entirely by woody vegetation and tall, dense herbaceous species. Horseshoe Island was similar but to a lesser degree. Purple loosestrife was common.



Phase 2 of the Lower Pool 8 Islands HREP project. The project restored islands in Stoddard Bay, Wisconsin. Sand islands were capped with fine sediment and seeded. East ends of islands E1 and E2 and D1 and D2 had sand mounds planted with American beachgrass for turtle nesting habitat. The rock dike, at left of photo, was constructed with a notch to allow flow into the area. Note aquatic vegetation growing around islands.

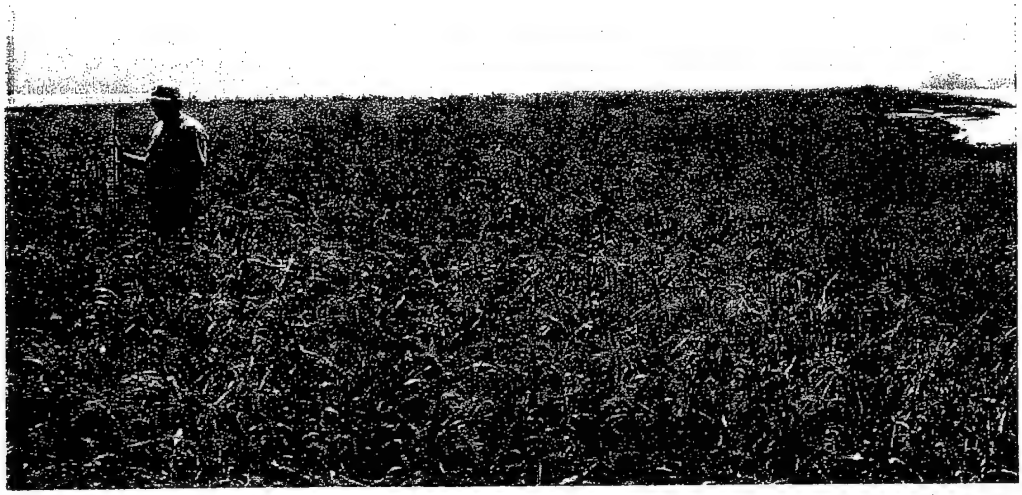
Island A in August 2000. Alfalfa was the dominant ground cover and formed a dense mat. Trees were planted, some with tubes, mats, or both. Voles girdled some of the trees. Survival was highest for trees with tubes.



Island B was seeded on May 4, 1999. In August 1999 when this photo was taken, it had 89% cover with a Robel reading of 6.8 decimeters. The most dominant species were foxtail, Muhlenbergia, and Canada wild rye. Based on monitoring results for other sites, it is likely that the abundance of foxtail will decline over time.

Island B in August 2000. Foxtail declined in importance while side oats grama and switchgrass increased. Percent cover and the Robel reading declined in 2000 to 56% and 2.4 decimeters.

Island C was seeded on June 18, 1999. This photo shows the vegetation in August 1999.



Island C in August 2000. The percent cover was 36% and dominated by Canada wild rye, black-eyed Susan, and Virginia wild rye.

Island D1 in August 2000. Trees were planted on this island to create the long-term cover. Ground cover consisted of alfalfa, brome, and Canada wild rye. Voles also girdled trees on this island, although to a lesser degree. Tree survival was better with tubes. Note good growth of willow along the shoreline to the right.

Island D2 in August 2000. The dominant species were Canada wild rye, side oats grama, and Virginia wild rye. Willow cuttings were doing well on most of the islands.

POOL 8 ISLANDS

Island E1 was seeded on May 19, 1999. In August 1999 when this photo was taken, it had 36% cover and a Robel reading of 1.3 decimeters. The dominant species were foxtail, Muhlenbergia, and wild oats. Wild oats was planted as the nurse crop and was eaten by Canada geese. One of the sand hills planted to beachgrass is at the end of the island.

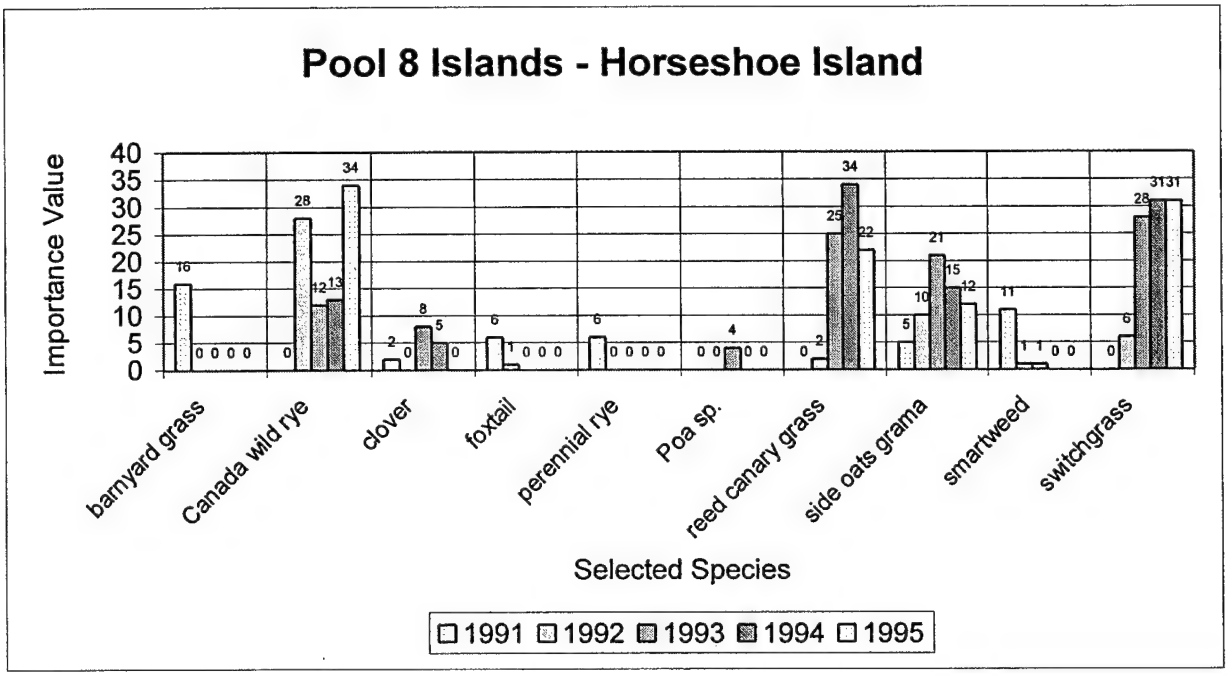
Island E1 in August 2000. Photograph shows one of the sand mounds planted with beachgrass stolons. The purpose of the sand mound was to create turtle habitat. Note willow cuttings along both shorelines.

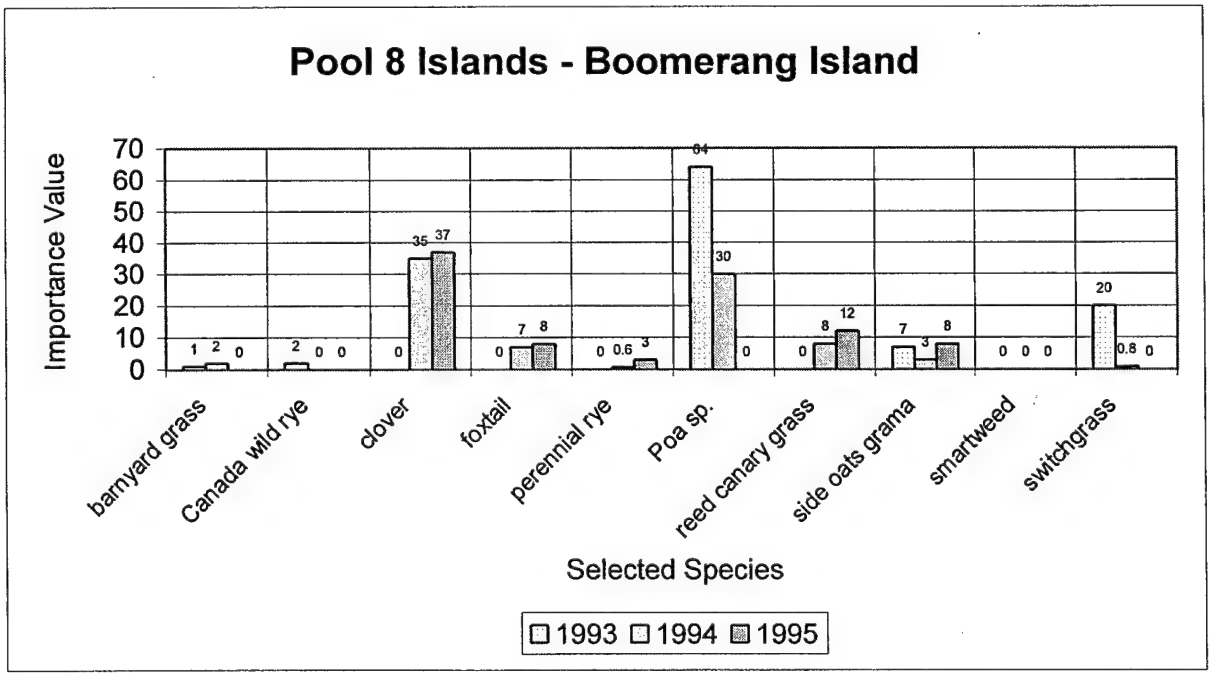
Island E2 was seeded on June 29, 1999. In August 1999 when this photo was taken, it had 28% cover, a Robel reading of 1 decimeter, and was dominated by foxtail, wild oats, and Muhlenbergia. Two rows of willow planted on the island can be seen next to the Robel pole and extend the length of the island. The willow cuttings were planted on July 13-15, 1999.

Island E2 in August 2000. Photograph shows one of the sand mounds. Seeded area in distance is dominated by foxtail, Canada wild rye, and side oats grama which had a percent cover of 56% and a Robel reading of 1.7 decimeters. Note good growth of willow cuttings along both shorelines.

SUMMARY TABLE OF POOL 8 ISLANDS SURVEY DATA

* seeded species	Frequency					Relative Frequency					Dominance					Relative Dominance					Importance Value				
	9/1991	8/1992	8/1993	8/1994	8/1995	9/1991	8/1992	8/1993	8/1994	8/1995	9/1991	8/1992	8/1993	8/1994	8/1995	9/1991	8/1992	8/1993	8/1994	8/1995	9/1991	8/1992	8/1993	8/1994	8/1995
POOL 8 ISLANDS - HORSESHOE ISLAND - EAST SIDE																									
barnyard grass	70					15					8					18					16				
bulrush	10					2					2					4					3				
*Canada wild rye		100	60	40	100		31	15	14	30		20	6	7	24		25	9	13	39		28	12	13	34
clammyweed	10					2					2					2					2				
clover	10		40	20		2		10	7		1		4	2		2		6	3		2		8	5	
evening primrose				7					2					0.1					0.3					1	
foxtail	20	7				4	2				3	0.1				8	0.1				6	1			
lambsquarters	10	7				2	2				1	0.1				0.5	0.1				1	1			
lovegrass	10					2					2					6					4				
mustard					7					2					0.1					0.1					1
pennycress		13					4					1					1					3			
*perennial rye	40					8					2					5					6				
Poa sp.			20					5					2					3					4		
reed canary grass		7	87	80	67		2	22	27	20		1	19	21	14		2	29	41	23		2	25	34	22
*side oats grama	40	47	87	60	7	8	14	22	20	2	1	4	13	5	3	3	5	20	9	5	5	10	21	15	12
smartweed	60	7	7			12	2	2			5	0.1	0.1			11	0.2	0.2			11	1	1		
*switchgrass		33	93	87	100		10	24	30	30		2	22	17	20		2	33	33	32		6	28	31	31
*thickspike wheatgrass	90	100				20	31				7	51				16	64				18	47			
thistle		7					2					0.3					0.4					1			
velvet leaf	10					2					2					5					3				
wild oats	100					21					9					20					20				
Average % Cover	34	78	66	51	61																				
Robel (decimeters)	1.3	2.1	2.6	2.9	5.2																				
POOL 8 ISLANDS - HORSESHOE ISLAND - WEST SIDE																									
barnyard grass	93					18					15					26					22				
*Canada wild rye	7	60				1	19				0.1	10				0.2	14				0.6	16			
clover	7					1					2					0.3					0.6				
dock		7					2					0.3					0.5					1			
foxtail	13	7				2	2				0.5	0.1				1	0.1				1.5	1			
lambsquarters	13					2					0.8					2					2				
mustard	7					1					0.5					0.3					0.6				
nightshade	7					1					2					3					2				
*perennial rye ?	67					13					5					9					11				
quackgrass	7					1					0.1					0.2					0.6				
red clover		20					6					2					3					5			
reed canary grass		47					15					14					20					17			
*side oats grama	47	53				9	17				3	8				6	11				8	14			
smartweed	67					13					4					7					10				
*switchgrass	7					1					2					3					2				
*thickspike wheatgrass	100	100				19	31				14	30				25	42				22	37			
wild oats	93					18					10					17					18				
yellow sweetclover		27					8					6					9					9			
Average % Cover	46	70																							
Robel (decimeters)	1.4	2																							
POOL 8 ISLANDS - BOOMERANG ISLAND, WITH WILLOW PLANTINGS																									
alfalfa			3	7				2	2				0.2	2				0.6	3				1	2	
barnyard grass			7					3					0.4					2					2		
blue vervain				7	7				2	2				0.3	0.5				0.5	1				1	2
boneset					3					1					0.3					0.6					1
*Canada wild rye				90	93				28	32				26	24				41	43				35	37
clover				30	33				9	11				3	3				5	5				7	8
dandelion				3					1					0.2					0.3					7	
dock			3					2					0.4					2					1		
foxtail			7	3				3	1				0.3	0.1				1	0.1				2	0.6	
goldenrod				3					1					0.3					0.5					0.8	
lambsquarters																									
marestail				3	13				1	5				0.1	1				0.1	2				0.6	3
*perennial rye			100	90				50	28				21	19				79	31				64	30	
plantain				7	10				2	3				0.3	0.5				0.5	1				1	2
Poa sp.																									
purple loosestrife				30	43				9	15				4	5				7	8				8	12
reed canary grass			13	10	13			2	3	5			2	2	6			7	4	12			7	3	8
sedge			3					2					0.1					0.2					1		
*side oats grama																									
smartweed			60	3				30	1				2	0.3				10	0.5				20	0.8	
*switchgrass			3	30	70			2	9	24			0.1	4	15			0.4	7	27			1	8	26
*thickspike wheatgrass																									
thistle					3					1					0.2					0.3					1
Average % Cover			26	62	55																				
Robel (decimeters)			0	2.2	4.8																				

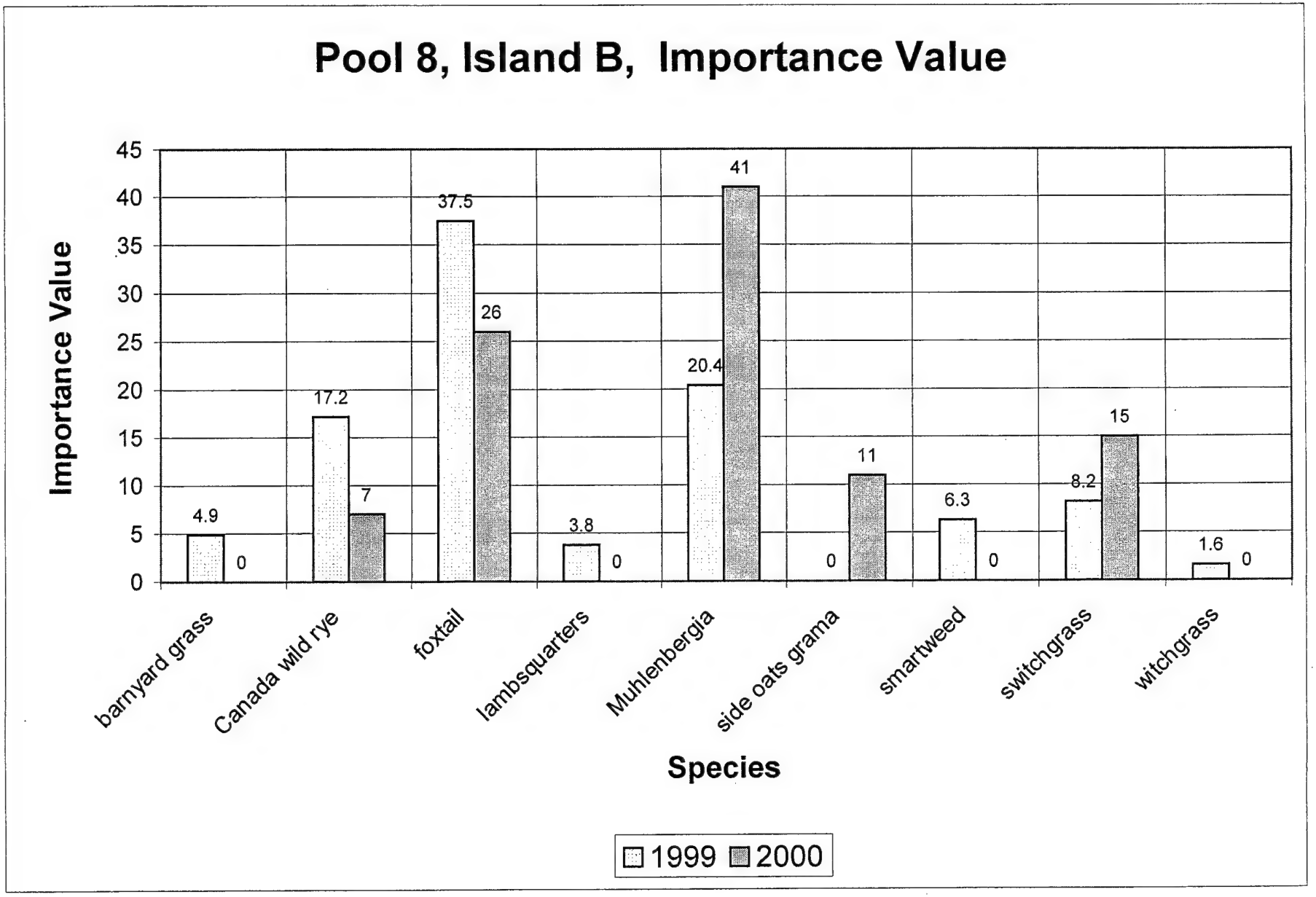




Pool 8 Islands. Comparison of Importance Value for selected species.

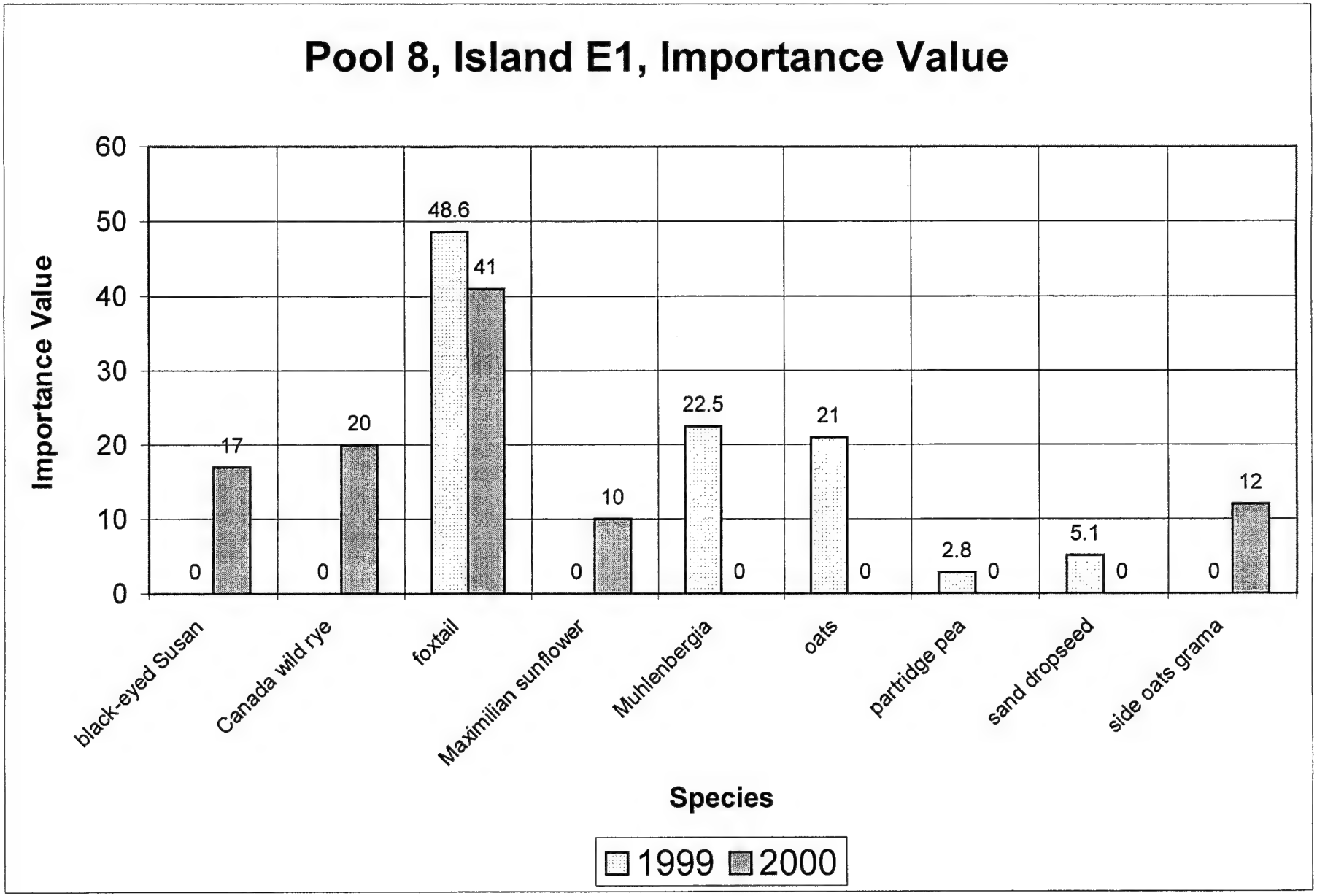
SUMMARY TABLE OF POOL 8 ISLANDS SURVEY DATA (continued)

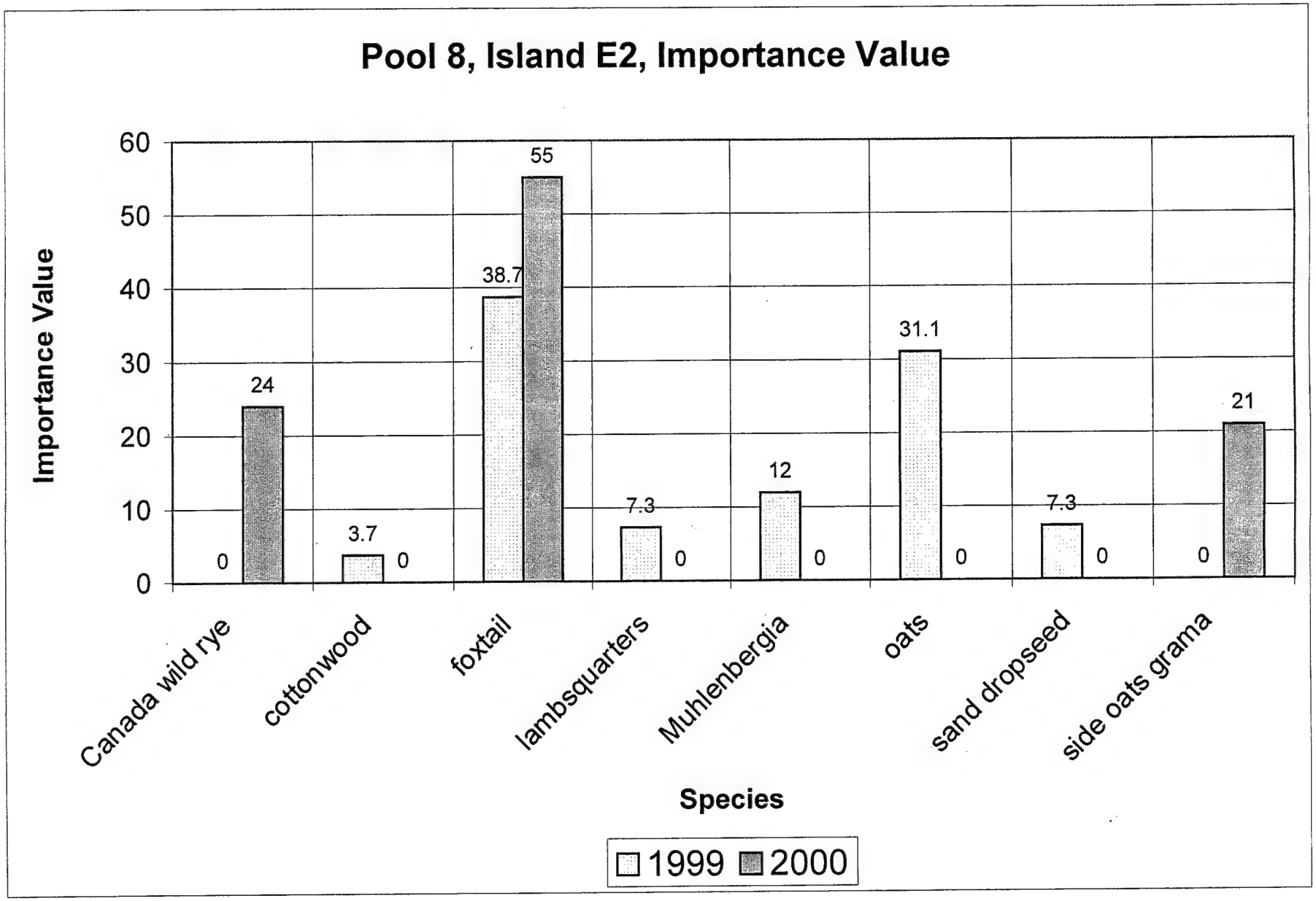
* seeded species	Frequency 8/1999	Frequency 8/2000	Relative Frequency 8/1999	Relative Frequency 8/2000	Dominance 8/1999	Dominance 8/2000	Relative Dominance 8/1999	Relative Dominance 8/2000	Importance Value 8/1999	Importance Value 8/2000
ISLAND A Phase 2										
*alfalfa		90		47		19		54		51
*brome		80		42		14		40		41
*oats										
reed canary grass		10		5		1		1		3
*timothy										
Virginia wild rye		10		5		2		4		5
Average % Cover		32								
Robel (decimeters)		1.8								
ISLAND B Phase 2										
barnyard grass	30		8.1		1.5		1.7		4.9	
*Canada wild rye	80	18	22	11	12	2	13	3	17	7
foxtail	100	45	27	28	43	14	48	25	38	26
lambsquarters	20		5.4		2		2.2		3.8	
*Maximilian sunflower										
Muhlenbergia	50	45	14	28	25	31	27	54	20	41
*oats										
*partridge pea										
*prairie clovers										
*sand bluestem										
*sand dropseed										
*side oats grama		18		11		6		10		11
smartweed	30		8.1		4		4.5		6.3	
*switchgrass	50	36	14	22	2.5	4	2.8	7	8.2	15
witchgrass	10		2.7		0.5		0.6		1.6	
Average % Cover	89	56								
Robel (decimeters)	6.8	2.4								
ISLAND C Phase 2										
*big bluestem										
*black-eyed Susan		70		27		13		35		31
*bluejoint reedgrass										
Canada wild rye		100		38		16		43		41
foxtail		10		4		1		1		3
*Indian grass										
*oats										
*prairie cordgrass										
*switchgrass		10		4		1		1		3
*Virginia wild rye		70		27		7		19		23
Average % Cover		36								
Robel (decimeters)		3.6								


Pool 8, Island B, Importance Value
Importance Value
45
40
35
30
25
20
15
10
5
0
4.9
0
17.2
7
37.5
26
3.8
0
20.4
41
0
11
6.3
0
8.2
15
1.6
0
barnyard grass
Canada wild rye
foxtail
lambsquarters
Muhlenbergia
side oats grama
smartweed
switchgrass
witchgrass
Species
1999
2000

SUMMARY TABLE OF POOL 8 ISLANDS SURVEY DATA (continued)

* seeded species	Frequency 8/1999	Frequency 8/2000	Relative Frequency 8/1999	Relative Frequency 8/2000	Dominance 8/1999	Dominance 8/2000	Relative Dominance 8/1999	Relative Dominance 8/2000	Importance Value 8/1999	Importance Value 8/2000
ISLAND D1 Phase 2										
*alfalfa		70		32		19		40		36
*brome		60		27		14		30		29
Canada wild rye		50		23		4		10		16
foxtail		20		9		4		7		8
*oats										
reed canary grass		10		5		2		4		4
*timothy										
Virginia wild rye		10		5		4		9		7
Average % Cover		47								
Robel (decimeters)		2.2								
ISLAND D2 Phase 2										
*Canada wild rye		50		29		16		44		37
*little bluestem										
*oats										
*prairie clovers										
*sand dropseed										
*side oats grama		70		41		10		27		34
*sunflowers										
Virginia wild rye		50		29		10		29		29
Average % Cover		36								
Robel (decimeters)		2.1								
ISLAND E1 Phase 2										
black-eyed Susan		40		18		7		15		17
*Canada wild rye		40		18		10		22		20
foxtail	100	80	32	36	26	21	65	46	49	41
*little bluestem										
*Maximilian sunflower		20		9		5		11		10
Muhlenbergia	88		28		6.8		17		23	
*oats	88		28		5.6		14		21	
*partridge pea	13		4		0.6		1.6		2.8	
*prairie clover										
*sand dropseed	25		8		0.9		2.2		5.1	
*side oats grama		40		18		3		7		12
Average % Cover	36	46								
Robel (decimeters)	1.3	1.3								
ISLAND E2 Phase 2										
*Canada wild rye		40		22		14		25		24
cottonwood	13		5.3		0.6		2		3.7	
foxtail	63	80	26	44	16	36	51	65	39	55
lambsquarters	25		11		1.2		4.1		7.3	
*little bluestem										
*Maximilian sunflower										
Muhlenbergia	38		16		2.5		8.2		12	
*oats	75		32		9.4		30		31	
*partridge pea										
*prairie clover										
*sand dropseed	25		11		1.2		4.1		7.3	
*side oats grama		60		33		5		9		21
Average % cover	28	55								
Robel (decimeters)	1	1.7								


Pool 8, Island E1, Importance Value
Importance Value
60
50
40
30
20
10
0
0
17
0
20
48.6
41
0
10
22.5
0
21
0
2.8
0
5.1
0
0
12
black-eyed Susan
Canada wild rye
foxtail
Maximilian sunflower
Muhlenbergia
oats
partridge pea
sand dropseed
side oats grama
Species
1999
2000


Pool 8, Island E2, Importance Value
Importance Value
60
50
40
30
20
10
0
0
24
3.7
0
38.7
55
7.3
0
12
0
31.1
0
7.3
0
0
21
Canada wild rye
cottonwood
foxtail
lambsquarters
Muhlenbergia
oats
sand dropseed
side oats grama
Species
1999
2000

Cold Springs, Pool 9, RM 653.0

Vegetation Measures

Cold Springs was an HREP project completed in 1994 and located in Pool 9 near Lynxville, Wisconsin. The site consisted of dredged material from the deepening of a nearby channel for fish access. The placement site contained predominantly fine sediments and was drill seeded in June 1994 with the following mixture and mulched.

Species	Seeding Rate
Canada wild rye	5 lbs. PLS/ac.
timothy	6 lbs./ac.
switchgrass	4 lbs. PLS/ac.
alsike clover	4 lbs./ac.
annual ryegrass	10 lbs./ac.

Monitoring Results

A Robel reading of 3.5 and 9.9 decimeters was recorded for the area in 1994 and 1997, respectively (Figure 17). The high Robel reading in 1997 was due to the tall, dense growth of switchgrass and purple loosestrife. This is one of the highest Robel readings ever recorded at sites on the Upper Mississippi River. The purple loosestrife was 7 feet tall in 1997. Although the Robel pole is intended to be used for grassland vegetation, it did give an indication of the density of ground cover at the site.

Total percent cover was estimated on each of the quarter-square-meter plots. The average percent cover in August 1994 and September 1997 was 95% and 91%, respectively (Figure 18). This is a very dense growth and is likely due to the placement of fine material, invasion of purple loosestrife, seeding, good summer growing conditions, and mesic to hydric conditions of the site.

The percent cover was also estimated for each species on the plot. The frequency, relative frequency, dominance, relative dominance, and importance value were also calculated for each species. On the basis of importance value, the three most important species found on the site were the following:

August 1994	September 1997
alsike clover	switchgrass
rye	purple loosestrife
smartweed	rice cutgrass

In 1997, the area had a very dense cover and was dominated by switchgrass and purple loosestrife in almost equal cover. The Jaccard Index of Species Similarity between the two years was 14. This indicates that there has been a large shift in species composition between the two years.

A variety of species is present including some "weedy" species and purple loosestrife. Weedy species have always been present, but by 1997 purple loosestrife had almost taken over the area. Willow had also increased along the shoreline by 1997. These conditions were similar in 1999.

Soil samples were also taken in 1997 to determine the percentage of fine material that was placed. Two samples were taken by Mr. Don Powell, St. Paul District, Corps of Engineers, earlier in the summer of 1997, and two more by Messrs. Gary Wege and Robert Anfang in August 1997. The results are as follows:

Powell:

Sample 1 dense vegetative cover:	58.3% fine material
Sample 2 no vegetative cover:	71.4% fine material

Wege and Anfang:

Sample 1 dense vegetative cover:	66.2% fine material
Sample 2 sparse vegetative cover:	68.1% fine material

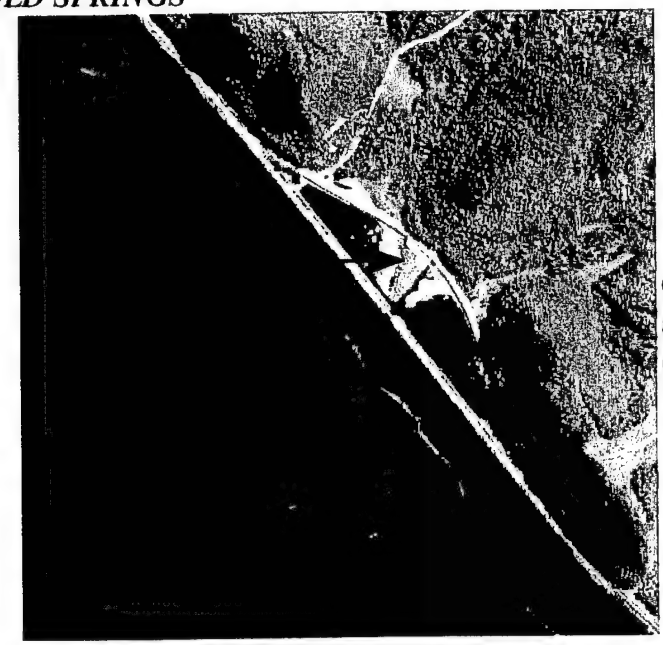
There does not seem to be any correlation between the percent of fine material at the site and the density of vegetation. Mr. Powell indicated that sample 2 was located in a slight depression and the lack of cover may have been due to standing water. This is a high percentage of fines. For future projects, it may be worthwhile to reduce the amount of fine material, as the same results may be obtained at lower cost.

The site was visited on August 18, 1999, but no sample plots were taken because the area was almost exclusively purple loosestrife and willow over 6 feet tall. There would be little value in detailed sampling. Vegetation was so dense and tall that it was nearly impossible to walk through.

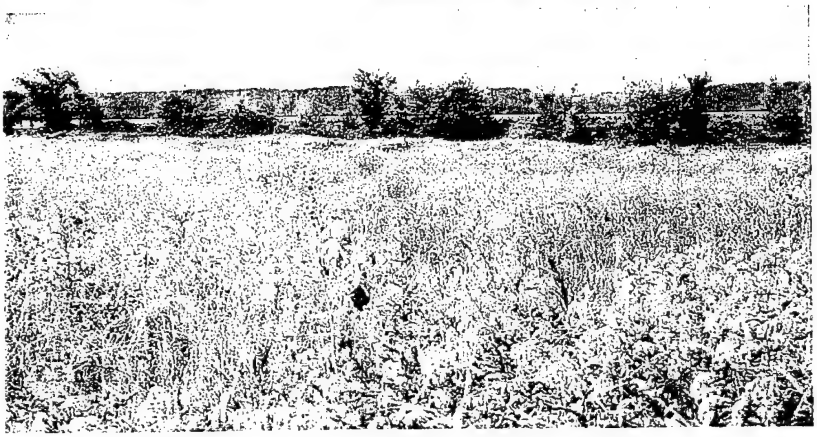
Summary

The seeded area was growing well but not with desired species. In 1994, there was a dominance of seeded species, relative sparsity of weedy species, and good overall percent cover. By 1997, switchgrass was the only seeded species present in any abundance. Purple loosestrife had taken over a large portion of the seeded area except the downstream shoreline. By 1999, the entire area consisted of an almost impenetrable stand of purple loosestrife with willow invading from the shoreline.

COLD SPRINGS



Cold Springs HREP project in Pool 9. Seeded area is located to the north of the excavated channel.



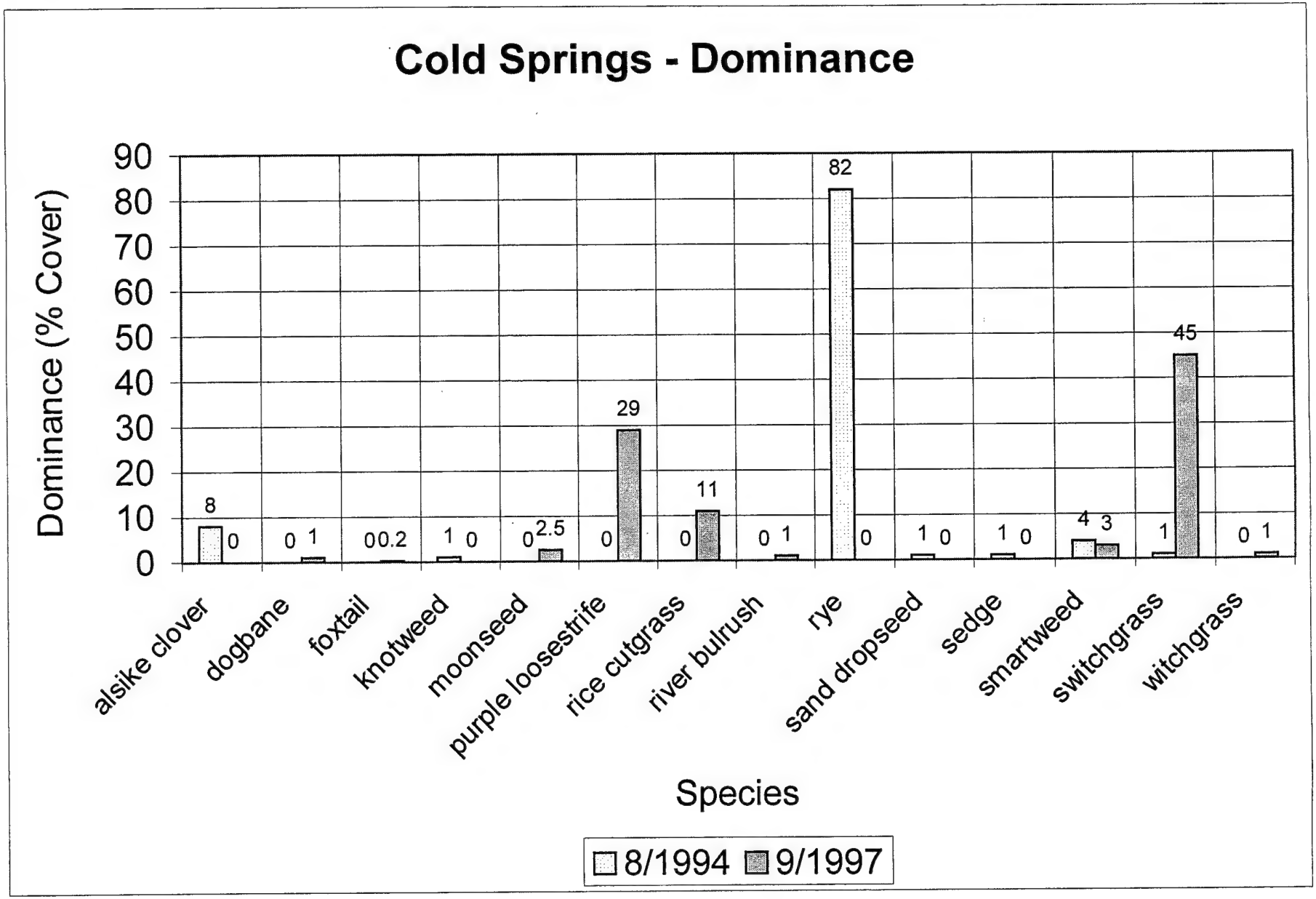
In August 1994, percent cover 95%, with a Robel reading 3.5 decimeters. Dominant species were clover, rye, and smartweed.

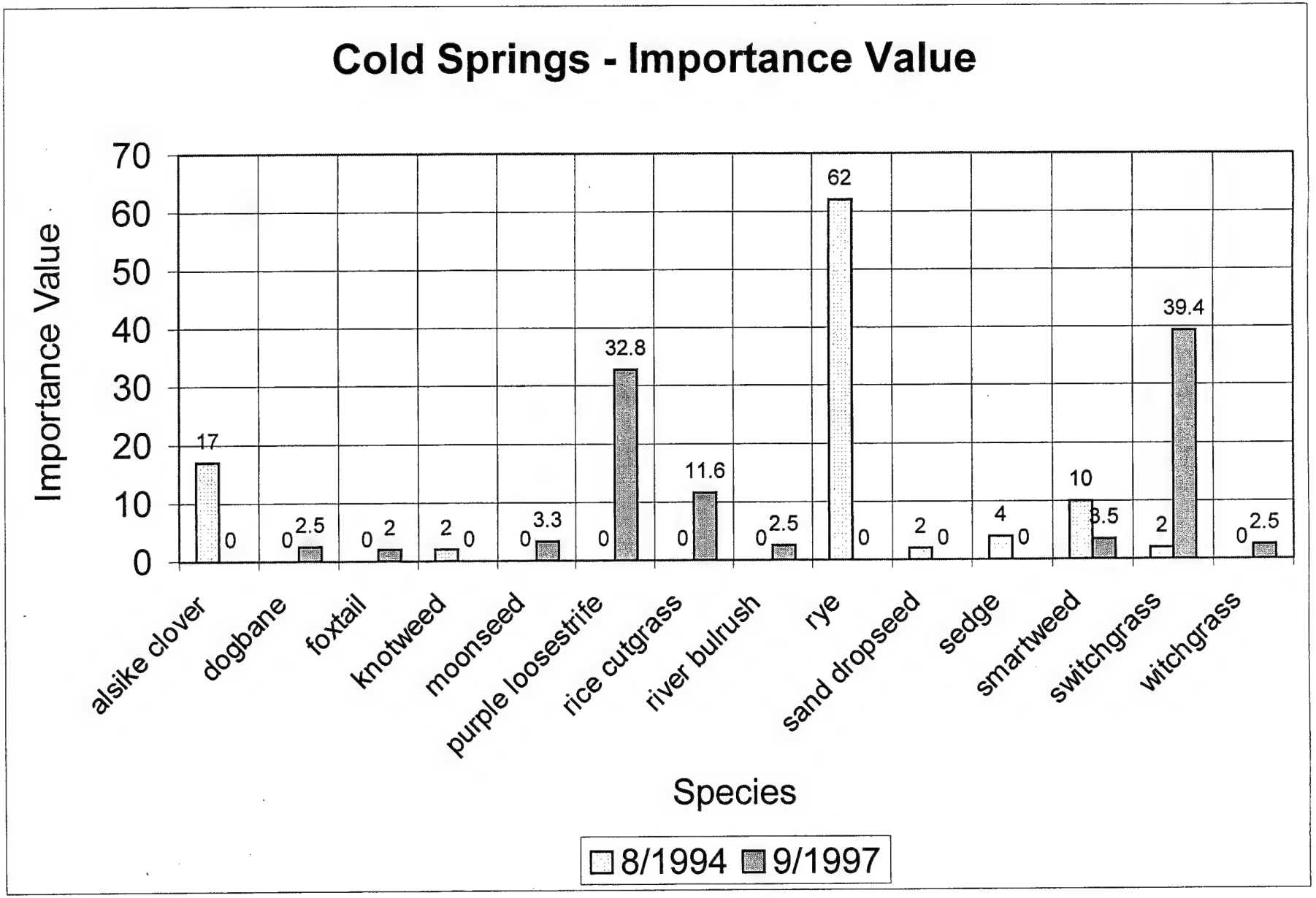
In August 1997, percent cover was 91% with a Robel reading of 9.9 decimeters. Dominant species were switchgrass and purple loosestrife.

In August 1999, dense willow and purple loosestrife created an almost impenetrable stand.

SUMMARY TABLE OF COLD SPRINGS SURVEY DATA

	Frequency		Relative Frequency		Dominance		Relative Dominance		Importance Value	
	8/1994	9/1997	8/1994	9/1997	8/1994	9/1997	8/1994	9/1997	8/1994	9/1997
* seeded species										
COLD SPRINGS										
*alsike clover	70		27		8		8		17	
*Canada wild rye										
dogbane		10		3.9		1		1.1		2.5
foxtail		10		3.9		0.2		0.2		2
knotweed	10		4		1		1		2	
moonseed		10		3.9		2.5		2.7		3.3
purple loosestrife		90		35.7		29		31		32.8
rice cutgrass		30		11.5		11		11.7		11.6
river bulrush		10		3.9		1		1.1		2.5
*rye	100		38		82		85		62	
sand dropseed	10		4		1		1		2	
sedge	20		8		1		1		4	
smartweed	40	10	15	3.9	4	3	4	3.2	10	3.5
*switchgrass	10	80	4	30.8	1	45	1	48	2	39.4
*timothy										
witchgrass		10		3.9		1		1.1		2.5
Average % cover	95	91								
Robel (decimeters)	3.5	9.9								


Cold Springs - Dominance
Dominance (% Cover)
90
80
70
60
50
40
30
20
10
0
8
0
0
1
0
0.2
1
0
0
2.5
0
29
0
11
0
1
82
0
1
0
1
0
4
3
1
45
0
1
alsike clover
dogbane
foxtail
knotweed
moonseed
purple loosestrife
rice cutgrass
river bulrush
rye
sand dropseed
sedge
smartweed
switchgrass
witchgrass
Species
8/1994
9/1997


Cold Springs - Importance Value
Importance Value
70
60
50
40
30
20
10
0
17
0
0
2.5
0
2
2
0
0
3.3
0
32.8
0
11.6
0
2.5
62
0
2
0
4
0
10
3.5
2
39.4
0
2.5
alsike clover
dogbane
foxtail
knotweed
moonseed
purple loosestrife
rice cutgrass
river bulrush
rye
sand dropseed
sedge
smartweed
switchgrass
witchgrass
Species
8/1994
9/1997

Indian Slough (Crats Island), Pool 4, RM 759.3

Vegetation Measures

Indian Slough was an HREP project completed in 1994 and located in Pool 4 near Wabasha, Minnesota, and Nelson, Wisconsin. The purpose of the project was to protect and enhance aquatic habitat in a backwater known as Big Lake. The Crats Island Dredged Material Placement Site (4-759.3-LWT) was used for the placement of material dredged to construct project features. Two areas adjacent to the placement site were chosen for planting. Fine sediment dredged from Big Lake was placed on the sites and the areas seeded in May 1994. Oak Root Production Method (RPM) trees were also planted on the sites; tree tubes were used to enhance growth and survival. In September 1995, the Fish and Wildlife Service hand cut willow throughout the north site.

The site includes the South Area which is downstream of the main placement site and the smaller North Area which is located upstream. Both areas were drill seeded with the following mixture and mulched.

Grass Species	Seeding Rate
big bluestem	3 lbs. PLS/ac.
little bluestem	3 lbs. PLS/ac.
Indian grass	3 lbs. PLS/ac.
switchgrass	3 lbs. PLS/ac.
side oats grama	1 lb. PLS/ac.
prairie dropseed	2 lbs. PLS/ac.
perennial rye	20 lbs./ac

The contract specified that a minimum of four of the forbs listed below were also to be seeded:

Wildflower Species	Seeding Rate
black-eyed Susan	4 oz./ac.
yellow coneflower	1 oz./ac.
rough blazing star	2 oz./ac.
prairie clovers	3 oz./ac.
leadplant	2 oz./ac.
stiff tickseed	3 oz./ac.

At a later date, rootstocks of the following native wildflowers were also planted.

North Area Species	Number of Rootstocks Planted
purple coneflower	50
early sunflower	50
compass-plant	50
prairie blazing star	50
button blazing star	50
oldfield goldenrod	75

South Area Species	Number of Rootstocks Planted
purple coneflower	25
early sunflower	25
compass-plant	50
prairie blazing star	25
oldfield goldenrod	25

Monitoring Results

A Robel reading of 1.9, 7.2, and 6.9 decimeters was recorded for the South Area in 1995, 1997, and 1999, respectively. The North Area had a Robel reading of 9.2 decimeters in 1999; this is very good growth. The high Robel readings were due to the very luxuriant growth of big bluestem which was about 6 to 8 feet tall and very dense.

Total percent cover was estimated on each of the quarter-square-meter plots. The average percent cover for the South Area was 41%, 84% and 82% in 1995, 1997, and 1999, respectively. The cover was fairly uniform over the area, but there were a few areas of denser cover in areas of lower elevation and perhaps more moist soil conditions. Big bluestem was by far the dominant species in the South Area. The percent cover in the North Area was 96% in 1999 and foxtail was common. See Figures 17 and 18 for a summary of Robel pole readings and percent cover estimates. The Jaccard Index of Species Similarity for 1999 indicates that the North and South Areas have about 20% of their species in common.

The percent cover was also estimated for each species on the plot. The frequency, relative frequency, dominance, relative dominance, and importance value were also calculated for each species. On the basis of importance value, the most important species found on the South Area were the following:

8/1995	9/1997	8/1999
foxtail	big bluestem	big bluestem
rye	Indian grass	black-eyed Susan
black-eyed Susan	foxtail	Indian grass

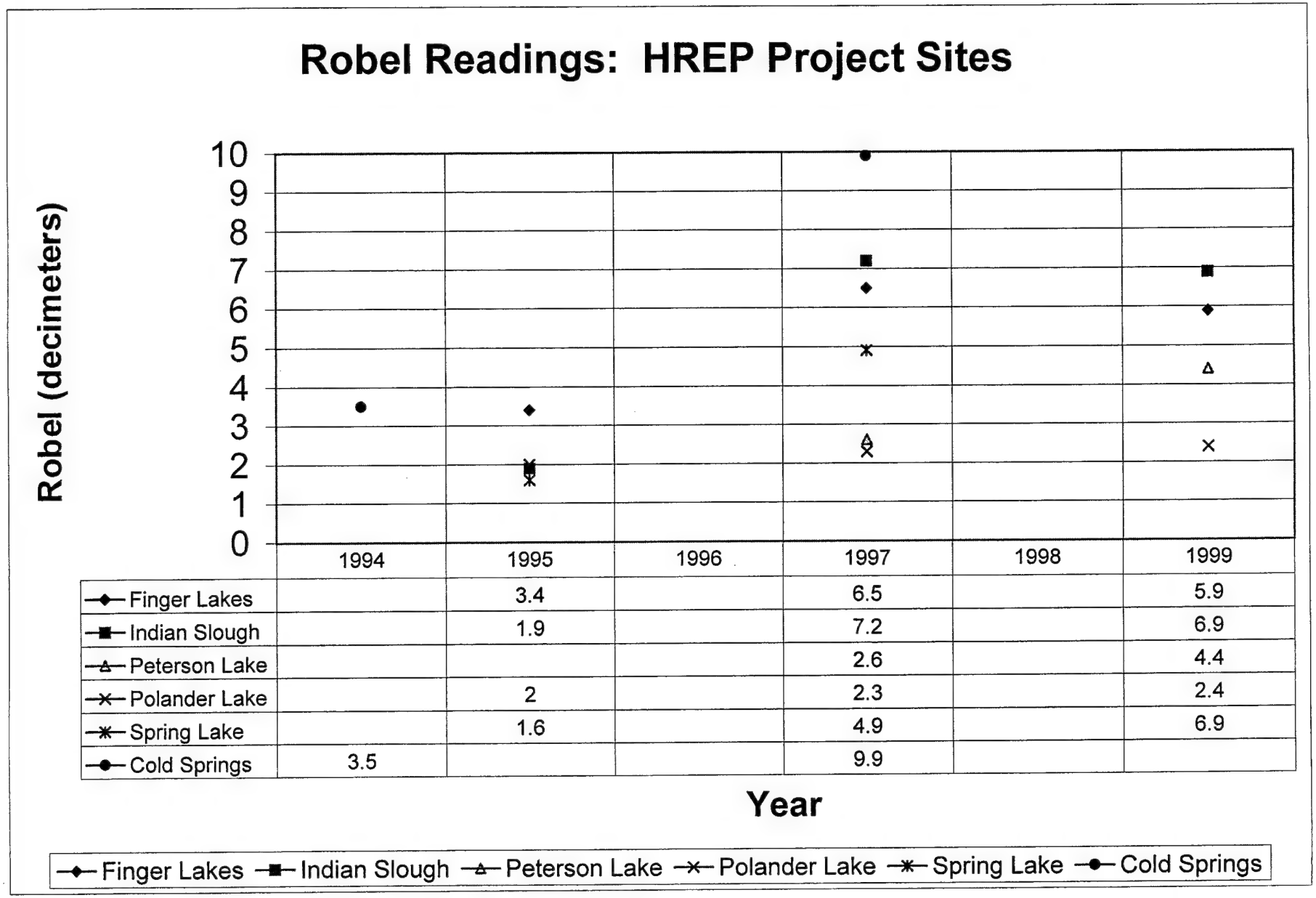
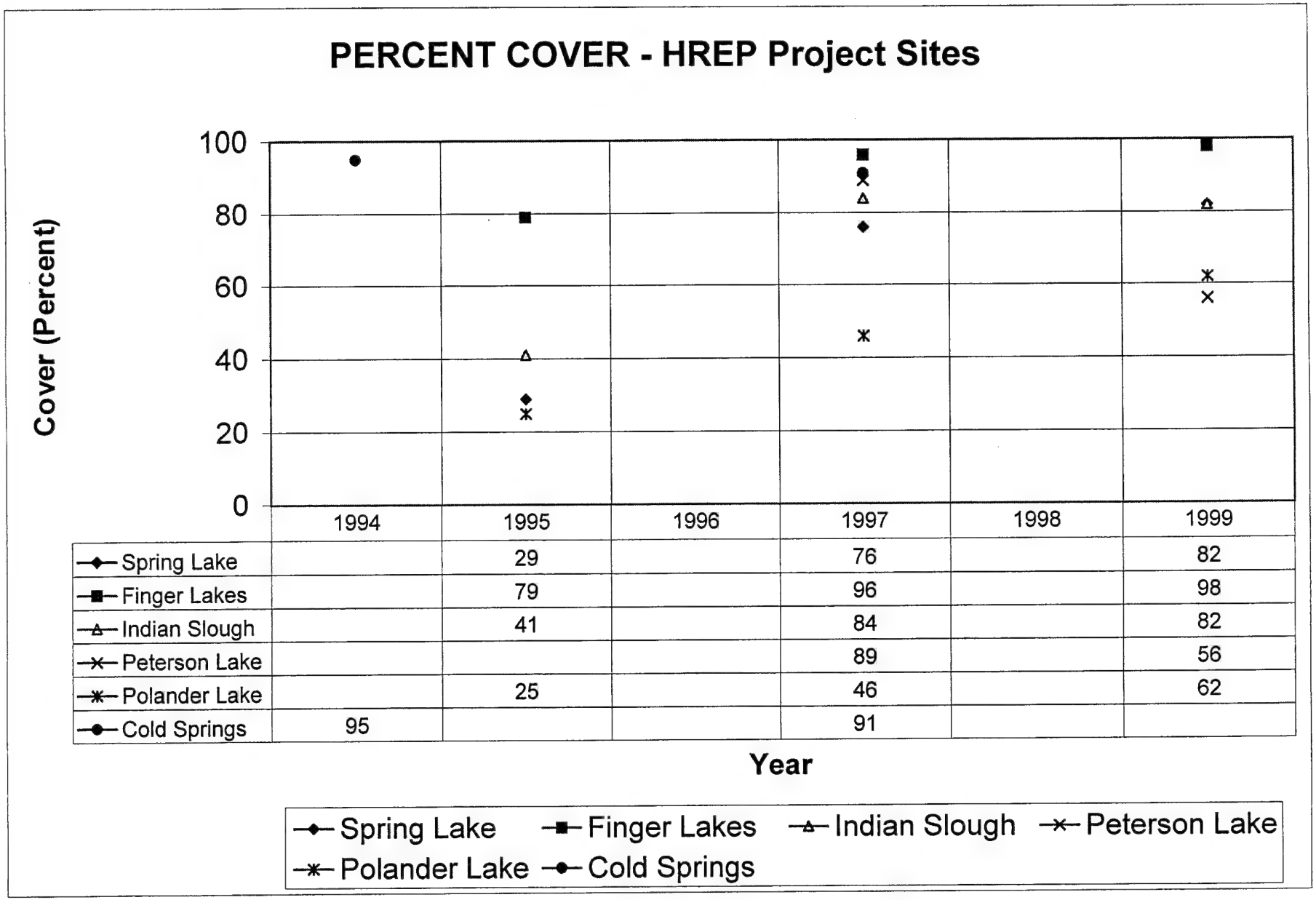


Figure 17. Robel readings for Finger Lakes, Indian Slough, Peterson Lake, Polander Lake, Spring Lake, and Cold Springs HREP projects. Results soon after seeding reflect foxtail growth at some sites. Later years contain more native grasses.



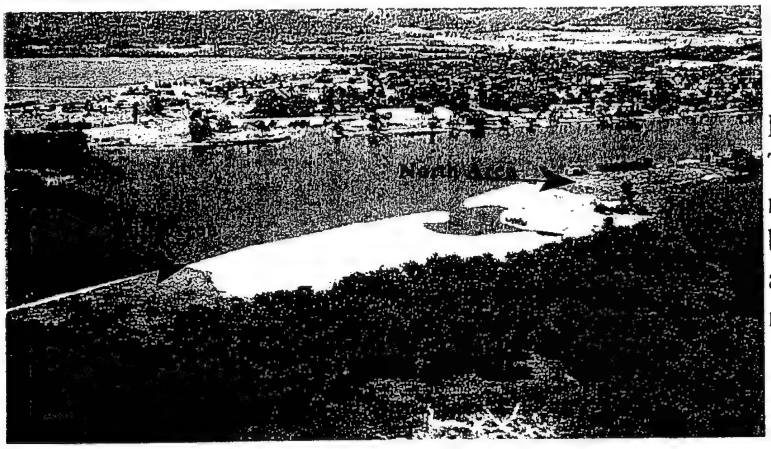
	1994	1995	1996	1997	1998	1999
Spring Lake		29		76		82
Finger Lakes		79		96		98
Indian Slough		41		84		82
Peterson Lake				89		56
Polander Lake		25		46		62
Cold Springs	95			91		

Figure 18. Percent cover estimates for Finger Lakes, Indian Slough, Peterson Lake, Polander Lake, Spring Lake, and Cold Springs HREP projects.

Summary

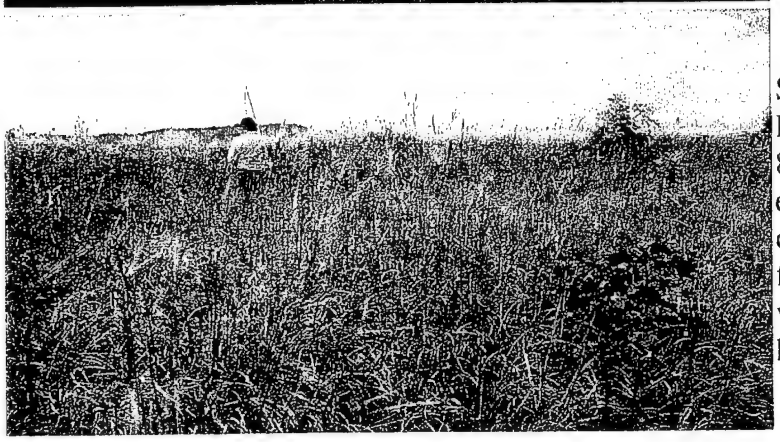
In 1995, foxtail and rye were by far the two most important species on the South Area. By 1997, both of these species had declined in importance and were replaced by big bluestem and Indian grass as the two most important species. By 1999, black-eyed Susan became a dominant species and switchgrass increased in importance. All of these species were planted in 1994. The dominant species on the North Area in 1999 were big bluestem and foxtail.

INDIAN SLOUGH

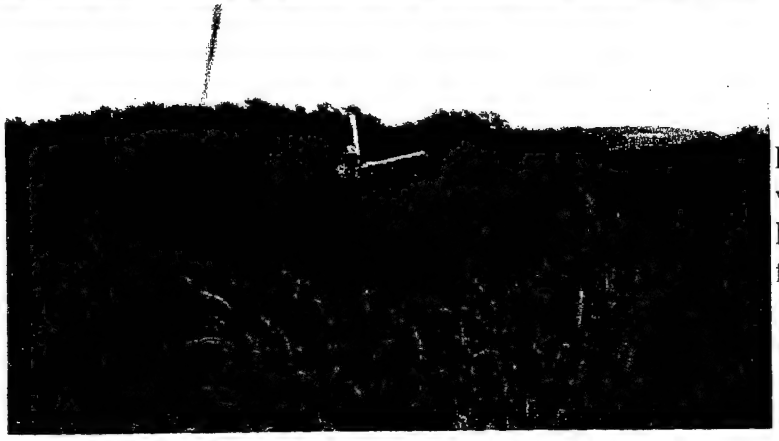


Indian Slough HREP site in Pool 4. The Crats Island long-term dredged material placement site is located between North and South vegetation areas. Both areas were seeded to native grasses in 1994.

South Area in August 1995 had a Robel reading of 1.9 decimeters with 41% cover. Foxtail and black-eyed Susan were common. Oak trees were planted in tree tubes in 1994.



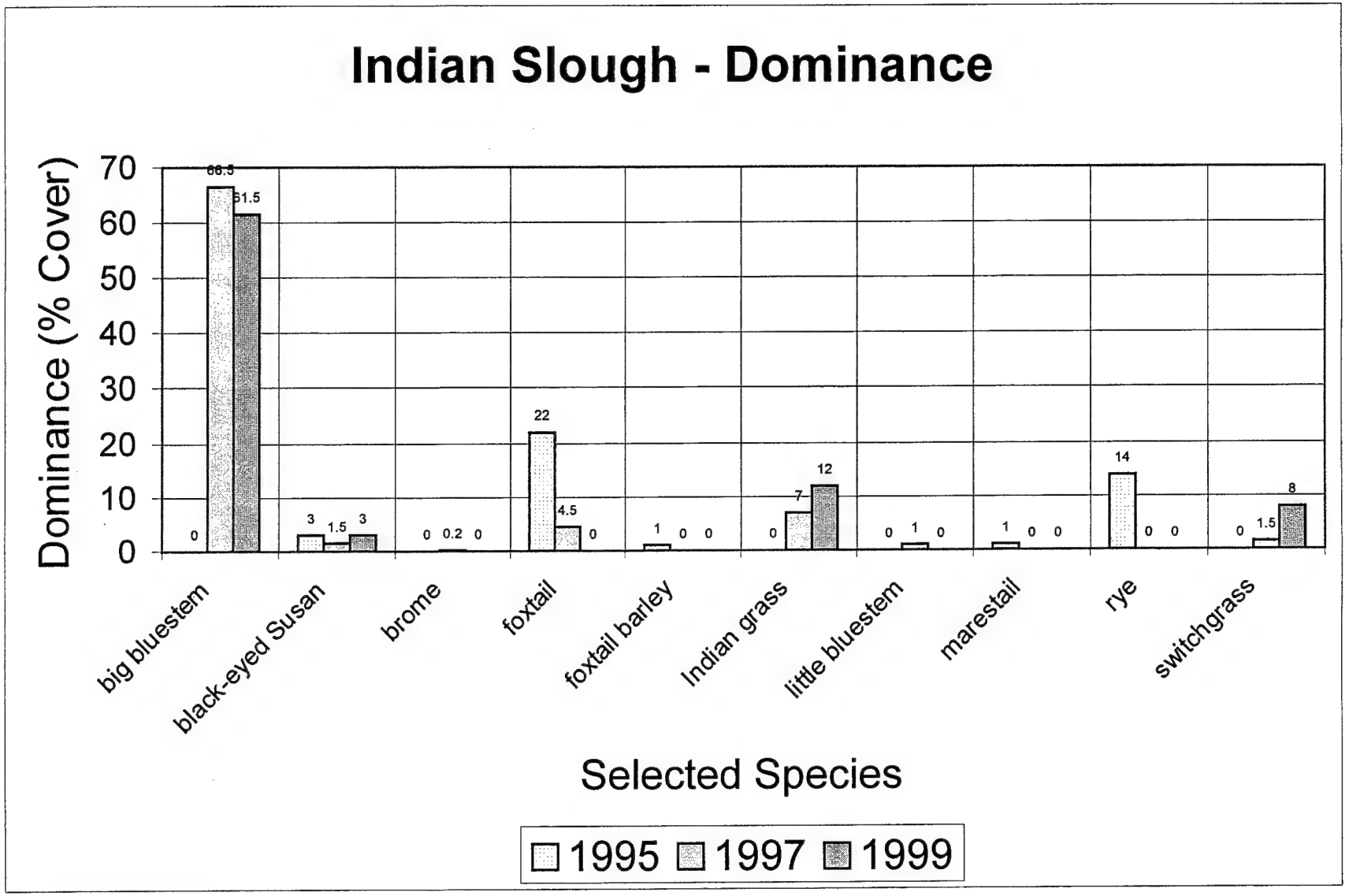
South Area in August 1999 had a Robel reading of 6.9 decimeters and 82% cover. Big bluestem, black-eyed Susan and Indian grass were common; big bluestem was 6 to 8 feet tall. Oak trees were growing well and many were over 6 feet in height.



In August 1999, planted species were also well established on the North Area. Big bluestem and foxtail were the dominant species.

SUMMARY TABLE OF INDIAN SLOUGH DATA

	Frequency			Relative Frequency			Dominance			Relative Dominance			Importance Value		
	8/1995	9/1997	8/1999	8/1995	9/1997	8/1999	8/1995	9/1997	8/1999	8/1995	9/1997	8/1999	8/1995	9/1997	8/1999
* seeded species															
INDIAN SLOUGH	South end of site														
*big bluestem		100	80		41.7	50		66.5	61.5		81.4	72.8		61.5	61.4
*black-eyed Susan	12	20	40	5	8.3	25	3	1.5	3	8	1.8	3.6	6	5.1	14.3
brome		10			4.2			0.2			0.2			2.2	
foxtail	100	20		42	8.3		22	4.5		54	5.3		48	6.6	
foxtail barley	12			5			1			3			4		
*Indian grass		20	20		8.3	12.5		7	12		8.3	14.2		16.7	13.4
*leadplant															
*little bluestem		10			4.2			1			1.1			2.7	
marestail	12			5			1			2			3		
*perennial rye (rye)	100			42			14			34			38		
*prairie clovers															
*prairie dropseed															
*rough blazing star															
*side oats grama															
*stiff tickseed															
*switchgrass		20	20		8.3	12.5		1.5	8		1.8	9.5		5.1	11
*yellow coneflower															
Average % cover	41	84	82												
Robel (decimeters)	1.9	7.2	6.9												
INDIAN SLOUGH	North end of site														
*big bluestem			100			50			56			58.3			54.2
*black-eyed Susan															
foxtail			100			50			40			41.7			45.8
*Indian grass															
*leadplant															
*little bluestem															
*perennial rye (rye)															
*prairie clovers															
*prairie dropseed															
*rough blazing star															
*side oats grama															
*stiff tickseed															
*switchgrass															
*yellow coneflower															
Average % cover			96												
Robel (decimeters)			9.2												


Indian Slough - Dominance
Dominance (% Cover)
70
60
50
40
30
20
10
0
66.5
61.5
0
3
1.5
3
0
0.2
0
22
4.5
0
1
0
0
0
7
12
0
1
0
1
0
0
14
0
0
0
1.5
8
big bluestem
black-eyed Susan
brome
foxtail
foxtail barley
Indian grass
little bluestem
marestail
rye
switchgrass
Selected Species
1995
1997
1999

Finger Lakes, Pool 4, RM 753.0

Vegetation Measures

Finger Lakes was an HREP project completed in 1994 in Pool 4 near Alma, Wisconsin. The site consists of dredged material resulting from construction of water control structures to improve fishery habitat. The Main Placement Area was capped with fine sediment and drill seeded in June 1994 with the following mixture and mulched. The area was mowed in 1994 to reduce a heavy growth of weeds.

Species	Seeding Rate
Canada wild rye	4 lbs. PLS/ac.
side oats grama	5 lbs. PLS/ac.
sand dropseed	4 lbs. PLS/ac.
little bluestem	3 lbs. PLS/ac.
switchgrass	3 lbs. PLS/ac.
red clover	3 lbs./ac.
wild oats	20 lbs./ac.

The access area was seeded with the following seed mixture.

Grass Species	Seeding Rate
big bluestem	3 lbs. PLS/ac.
little bluestem	3 lbs. PLS/ac.
Indian grass	2 lbs. PLS/ac.
switchgrass	3 lbs. PLS/ac.
side oats grama	1 lb. PLS/ac.
Canada wild rye	3 lbs. PLS/ac.

Wildflower Species	Seeding Rate
black-eyed Susan	4 oz./ac.
yellow coneflower	1 oz./ac.
rough blazing star	2 oz./ac.
white prairie clover	1.5 oz./ac.
purple prairie clover	1.5 oz./ac.
leadplant	2 oz./ac.
stiff tickseed	3 oz./ac.
bush clover	3 oz./ac.

In addition, wildflower plantings were conducted at later times. The species used were as follows:

Wildflower Species	Number of Rootstocks Planted
purple coneflower	100
pale purple coneflower	50
early sunflower	50
compass-plant	50
button blazing star	100
prairie blazing star	75
butterfly weed	50

The exact areas seeded and the seed/plant mixture used are somewhat confusing. From field observations, it appears that two main areas were seeded with different mixtures. Both the Corps of Engineers and the Fish and Wildlife Service conducted seeding at separate times. In 1999, they separated the site into two areas: the Main Placement Area where most of the excavated material was disposed, and the Access Area which was used for equipment access to the site.

Monitoring Results

A Robel reading of 3.4, 6.5, and 5.9 decimeters was recorded for the site in 1995, 1997, and 1999, respectively; this represented very good height/density of cover. Total percent cover was estimated on each of the quarter-square-meter plots; results were similar to the Robel readings. The average percent cover was 79% in 1995, 96% in 1997, and 98% in 1999. The Access Area had a percent cover of 66% in 1999. The good growth is probably due to the placement of fine material, seeding, good summer growing conditions, and mesic to hydric conditions of the site. There was a significant difference in the percent cover between the Access and Main Placement Areas in 1999. The Access Area was less dense and contained more prairie species, while the Main Placement Area was dominated by dense switchgrass. See Figures 17 and 18 for a summary of Robel pole readings and percent cover estimates. The Jaccard Index of Species Similarity between the Access Area and the Main Placement Area was 8 in 1999, indicating that the areas are vastly different in species composition.

The percent cover was estimated for each species on the plot. The frequency, relative frequency, dominance, relative dominance, and importance value were also calculated for each species. On the basis of importance value, the three most important species found on the site were the following:

August 1995	September 1997	August 1999	
		Main Area	Access Area
side oats grama	switchgrass	switchgrass	Indian grass
red clover	side oats grama	side oats grama	side oats grama
Canada wild rye	reed canary grass	marestail & mint	blazing star & black-eyed Susan

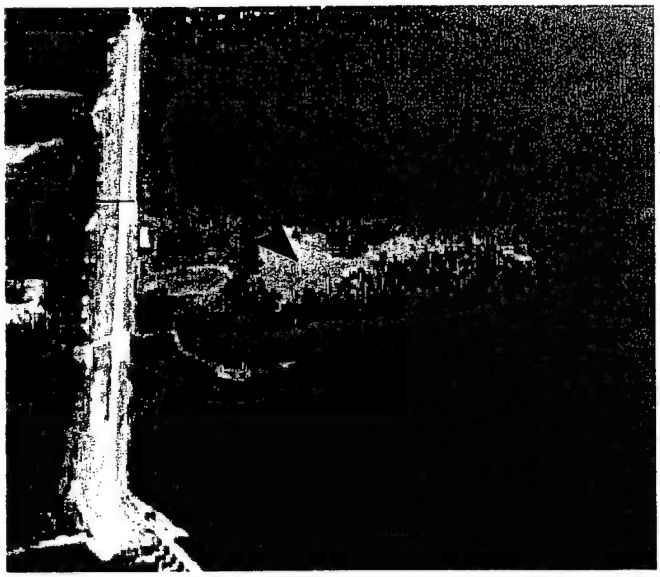
In 1999, the site had a very dense cover and appeared to be fairly uniform throughout. Switchgrass had become a dominant species in the Main Placement Area and was 5 feet or more in height. Much of the switchgrass was knocked down, apparently from wind/rain blowing to the northeast in 1999. White clover, Canada wild rye, and side oats grama have declined over time. It will be interesting to see if the dense cover of switchgrass will result in the "suffocation" of growth, as seems to have happened at two of the Lake Onalaska Island sites.

A variety of species are present at both areas, including some "weedy" species. However, there are fewer weedy species and they are less dominant in the Access Area. The Access Area also contains many more prairie species (grasses and forbs). Both areas are very different, as shown by the Jaccard Index of Species Similarity which has a value of 8. Soil characteristics or seed mixtures may be reasons; the Access Area also appears to be more sandy.

Summary

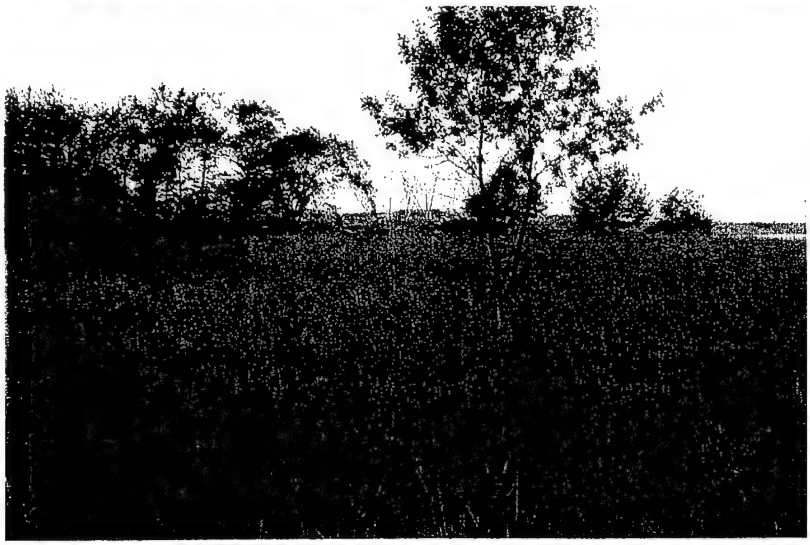
The seeded areas appeared to be growing well. There was a dominance of seeded species, relative sparsity of weedy species, good overall percent cover, fairly uniform cover, and a Robel reading that exceeded HREP project goals of 1.5 decimeters after 2 years of growth. Switchgrass appeared to be increasing at the expense of other species in the Main Placement Area and had been knocked down, probably by wind/rain. Over the years, switchgrass has become very dense and dominates the Main Placement Area. The Access Area was dominated by a less dense cover of prairie species (grasses and forbs).

FINGER LAKES



Finger Lakes HREP project site in Pool 4. Two areas were seeded in 1994. The seeded area to the right on the peninsula is the Access Area which contained more prairie grasses and forbs. The Main Disposal Area is larger open area on the peninsula which had denser vegetation and was dominated by switchgrass.

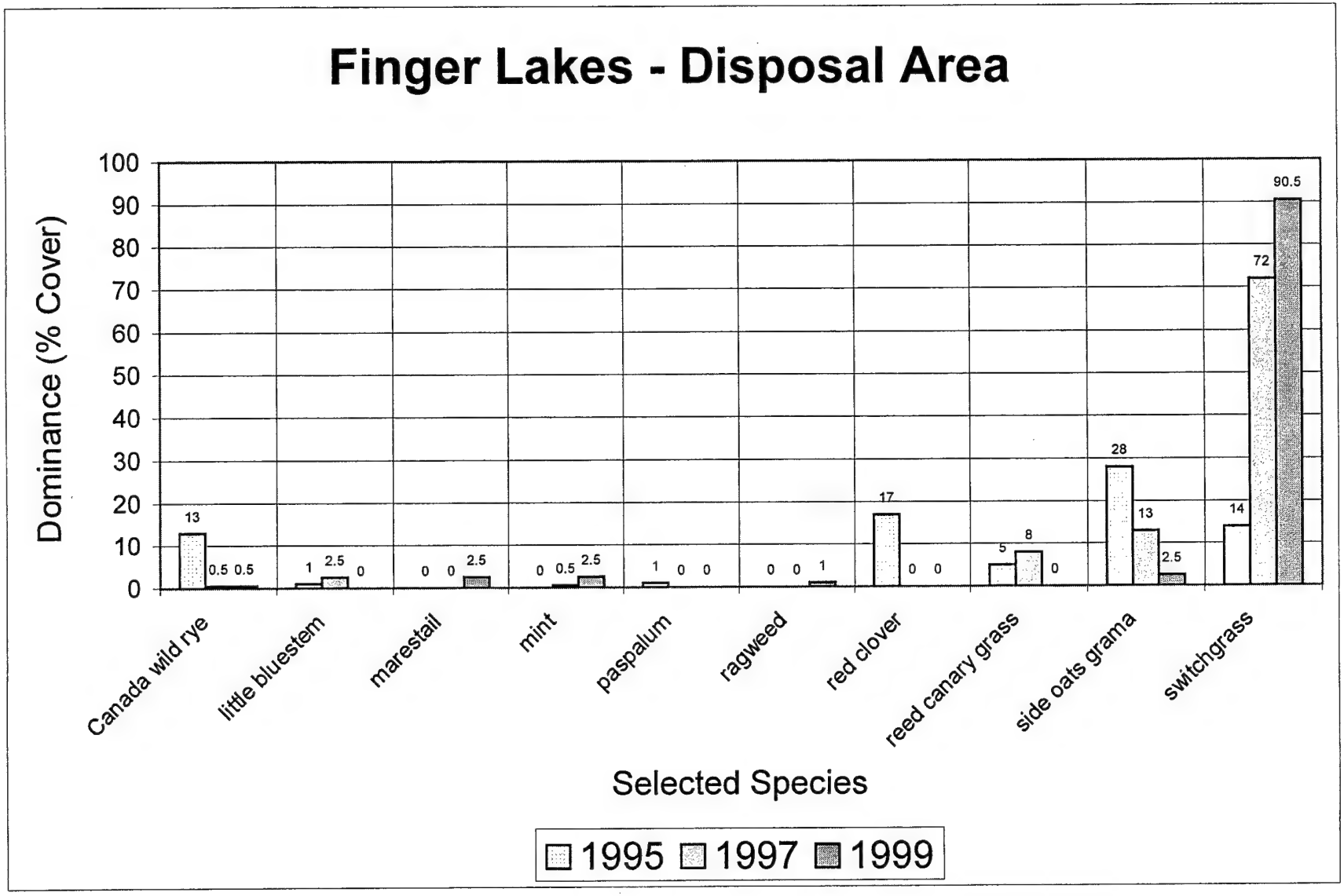
Main Disposal Area in August 1995. The 79% cover was composed mostly of side oats grama, red clover, and Canada wild rye. By 1999, switchgrass became dominant.

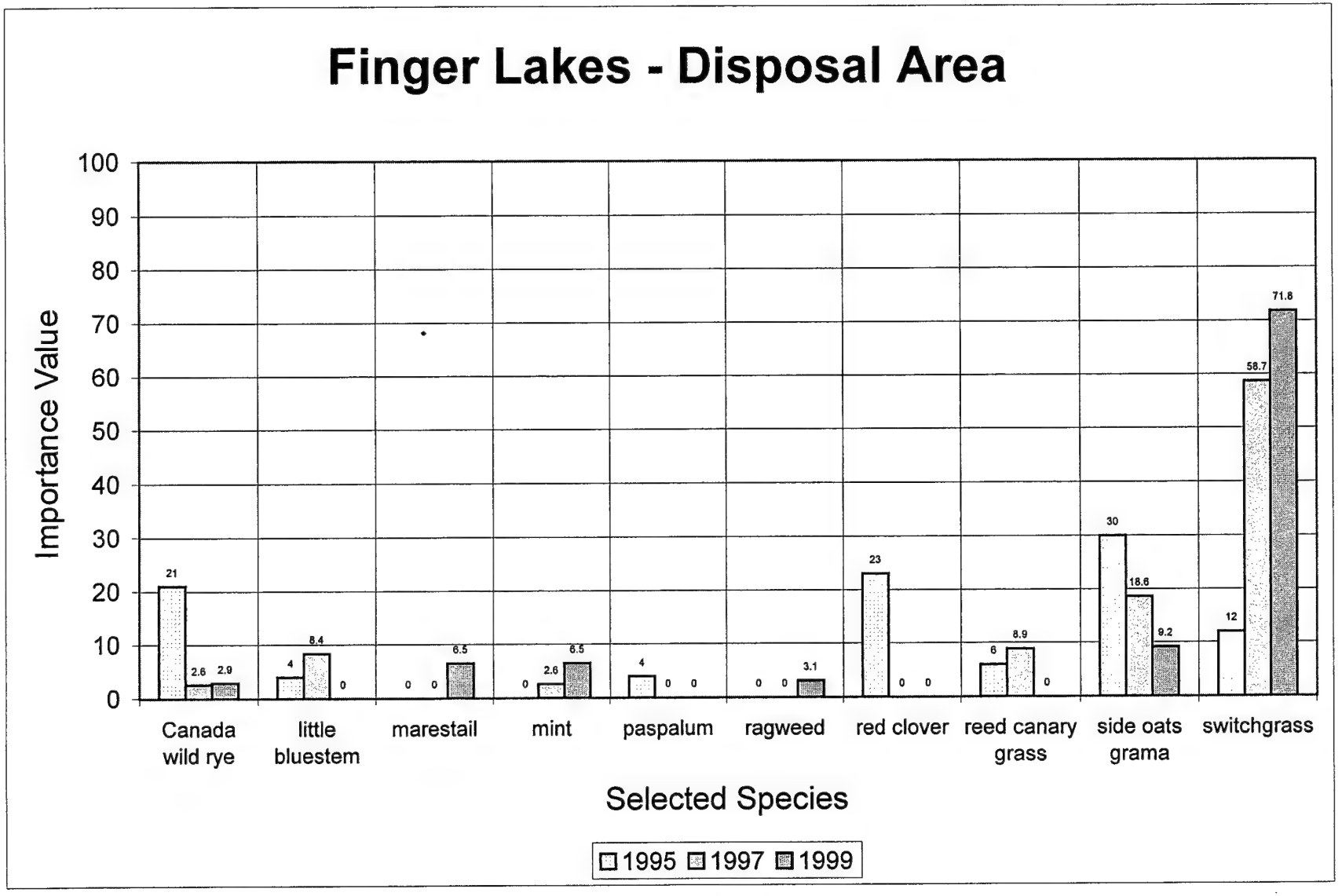


This photo shows the Access Area in August 1999. Native prairie species were dominant including Indian grass, side oats grama, blazing star, and black-eyed Susan. Percent cover was 66% with a Robel reading of 2.8 decimeters.

SUMMARY TABLE OF FINGER LAKES SURVEY DATA

	Frequency			Relative Frequency			Dominance			Relative Dominance			Importance Value		
	8/1995	9/1997	8/1999	8/1995	9/1997	8/1999	8/1995	9/1997	8/1999	8/1995	9/1997	8/1999	8/1995	9/1997	8/1999
* seeded species															
FINGER LAKES - Disposal Area															
*Canada wild rye	80	10	10	25	4.8	5.3	13	0.5	0.5	16	0.5	0.5	21	2.6	2.9
*little bluestem	20	30		6	14.3		1	2.5		1	2.6		4	8.4	
marestail			20			10.5			2.5			2.5			6.5
mint		10	20		4.8	10.5		0.5	2.5		0.5	2.51		2.6	6.5
paspalum	20			6			1			1			4		
ragweed			10			5.3			1			1			3.1
*red clover	80			25			17			22			23		
reed canary grass	20	20		6	9.5		5	8		6	8.3		6	8.9	
*sand dropseed															
*side oats grama	80	50	30	25	23.8	15.8	28	13	2.5	35	13.5	2.5	30	18.6	9.2
*switchgrass	20	90	100	6	42.9	52.6	14	72	90.5	18	74.6	91	12	58.7	71.8
*wild oats															
Average % cover	29	76	82												
Robel (decimeters)	3.4	6.5	5.9												
FINGER LAKES - Access Area															
*big bluestem															
bindweed			10			5			0.5			0.7			2.9
*black-eyed Susan			20			10			1			1.5			5.7
*blazing star			20			10			1			1.5			5.7
*bush clover															
*Canada wild rye															
*Indian grass			100			50			62.5			92.6			71.3
*leadplant															
*little bluestem			10			5			0.5			0.7			2.9
prairie clover			10			5			0.5			0.7			2.9
*purple prairie clover															
*red clover															
*sand dropseed															
*side oats grama			30			15			1.5			2.2			8.6
*stiff tickseed															
*switchgrass															
*white prairie clover															
*wild oats															
*yellow coneflower															
Average % cover			66												
Robel (decimeters)			2.8												


Finger Lakes - Disposal Area
Dominance (% Cover)
100
90
80
70
60
50
40
30
20
10
0
13
0.5 0.5
1 2.5 0
0 0 2.5
0 0.5 2.5
1 0 0
0 0 1
17
0 0
5 8 0
28
13
2.5
14
72
90.5
Canada wild rye
little bluestem
marestail
mint
paspalum
ragweed
red clover
reed canary grass
side oats grama
switchgrass
Selected Species
1995 1997 1999


Finger Lakes - Disposal Area
Importance Value
100
90
80
70
60
50
40
30
20
10
0
21
2.6
2.9
4
8.4
0
0
0
6.5
0
2.6
6.5
4
0
0
0
0
3.1
23
0
0
6
8.9
0
30
18.6
9.2
12
58.7
71.8
Canada wild rye
little bluestem
marestail
mint
paspalum
ragweed
red clover
reed canary grass
side oats grama
switchgrass
Selected Species
1995
1997
1999

Polander Lake, Pool 5A, RM 729.3

Vegetation Measures

Polander Lake was an HREP project, Stage 1 of which was completed in 1994, located in Pool 5A near Fountain City, Wisconsin. The seeded area was a placement site for dredged material from the dredging of bottom sediments in Polander Lake to improve fishery habitat and the construction of breakwaters. The area was drill seeded in October 1994 with the following mixture and mulched.

Grass Species	Seeding Rate
big bluestem	4 lbs. PLS/ac.
side oats grama	5 lbs. PLS/ac.
Indian grass	3 lbs. PLS/ac.
sand dropseed	3 lbs. PLS/ac.
perennial ryegrass	10 lbs./ac.
prairie clovers	3 oz./ac.

In addition, the following native wildflowers were planted at a later date.

Wildflower Species	Number of Rootstocks Planted
purple coneflower	25
early sunflower	25
compass-plant	50
button blazing star	50
oldfield goldenrod	50
prairie onion	50

As part of the management plan for Polander Lake, the site has been prescribed burned at least twice by the Fish and Wildlife Service-Winona Office.

Monitoring Results

A Robel reading of 2.0 decimeters was recorded for the area in 1995. This was good height/density for the first year's growth. A Robel reading of 2.3 was recorded in 1997 and 2.4 in 1999; both readings exceed the HREP goal of 1.5 decimeters after 2 years of growth.

Total percent cover was estimated on each of the quarter-square-meter plots. The average percent cover was 25% in 1995. This was not very dense, but it was only the first growing season. The vegetation cover was not uniform and varied considerably. The percent cover in 1997 was 46%, but it was not significantly different from 1995. The variability of cover may be due to the amount and uniformity of fine material spread at the site. In 1999, the total estimated percent cover was 62%, but it was not significantly different from the 1997 percent cover. See Figures 17 and 18 for a summary of Robel pole readings and percent cover estimates.

The percent cover was estimated for each species on the plot. The frequency, relative frequency, dominance, relative dominance, and importance value were also calculated for each species. On the basis of importance values, the three most important species found on the site were the following:

August 1995	September 1997	August 1999
foxtail	big bluestem	big bluestem
rye	side oats grama	switchgrass
side oats grama	Indian grass	side oats grama

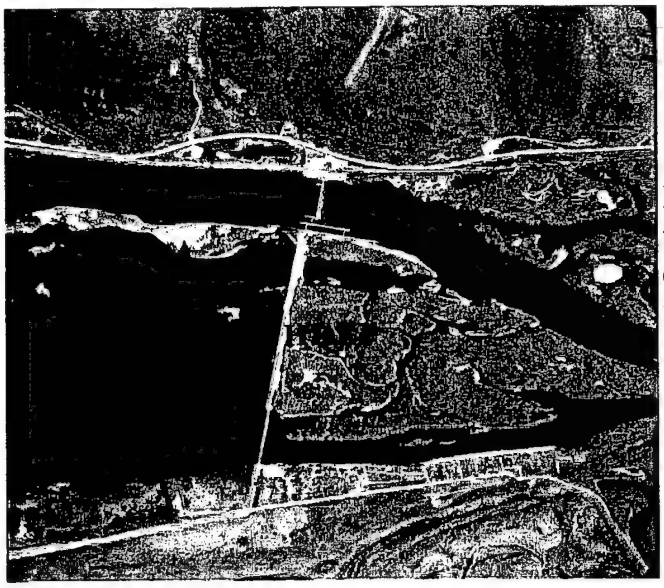
The Jaccard Index of Species Similarity was 10 between 1995 and 1997. Between 1997 and 1999, about one-third of the species were in common, indicating a large change in species composition since 1995.

A variety of species are present at the site, including some "weedy" species. Oak "Root Production Method Trees" were also planted at the site by the La Crescent Office of the Corps of Engineers. These are fast-growing trees and produce acorns early. In 1997, they were growing very well and were about 3 to 4 feet tall. In 1999, almost all of the trees exhibited top die-back, presumably from prescribed burns conducted by Fish and Wildlife Service refuge personnel for wildlife habitat management purposes. However, the trees were still alive and resprouting from the base or lower branches.

Summary

In 1995, foxtail was the dominant species at the site, along with the seeded species of rye and side oats grama; percent cover was 25%. The 1995 Robel reading of 2.0 decimeters was good for the first year's growth and exceeded HREP goals. The vegetation density was not uniform throughout the area, and there were pockets of dense stands of predominantly foxtail. It was anticipated that foxtail would decline over time, and in 1997, seeded species dominated the site and it began to resemble a prairie environment. In 1997, big bluestem and side oats grama were still dominant but switchgrass had increased in importance; total percent cover was 46% in 1997. Percent cover increased to 62% in 1999 and vegetation was well established.

POLANDER LAKE



Polander Lake HREP project in Pool 5A. Sand at the disposal site was capped with fine sediment and seeded to native grasses in October 1994.

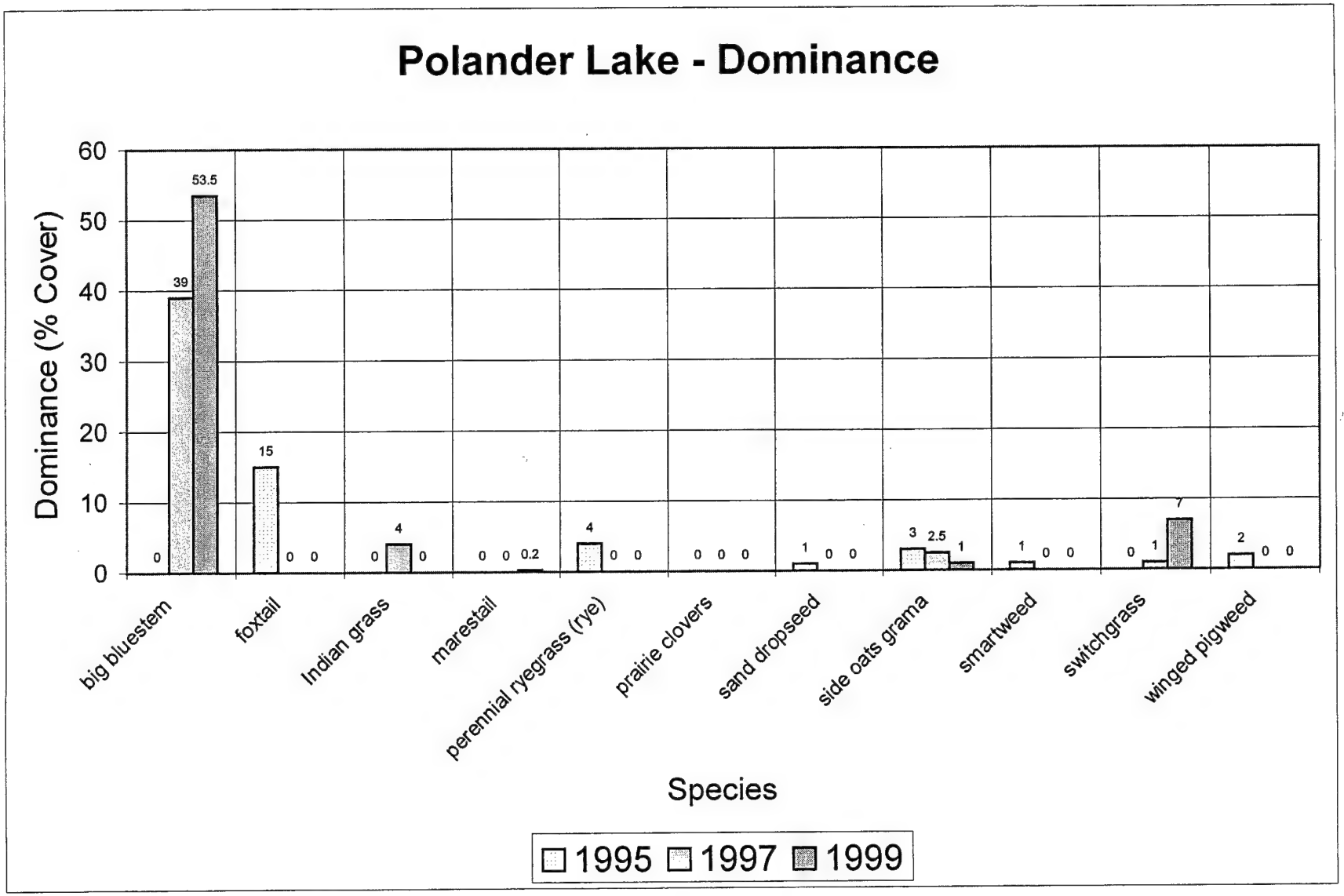
In August 1995, the percent cover was 25% and the Robel reading was 2.0 decimeters. Dominant species were foxtail, rye, and side oats grama.

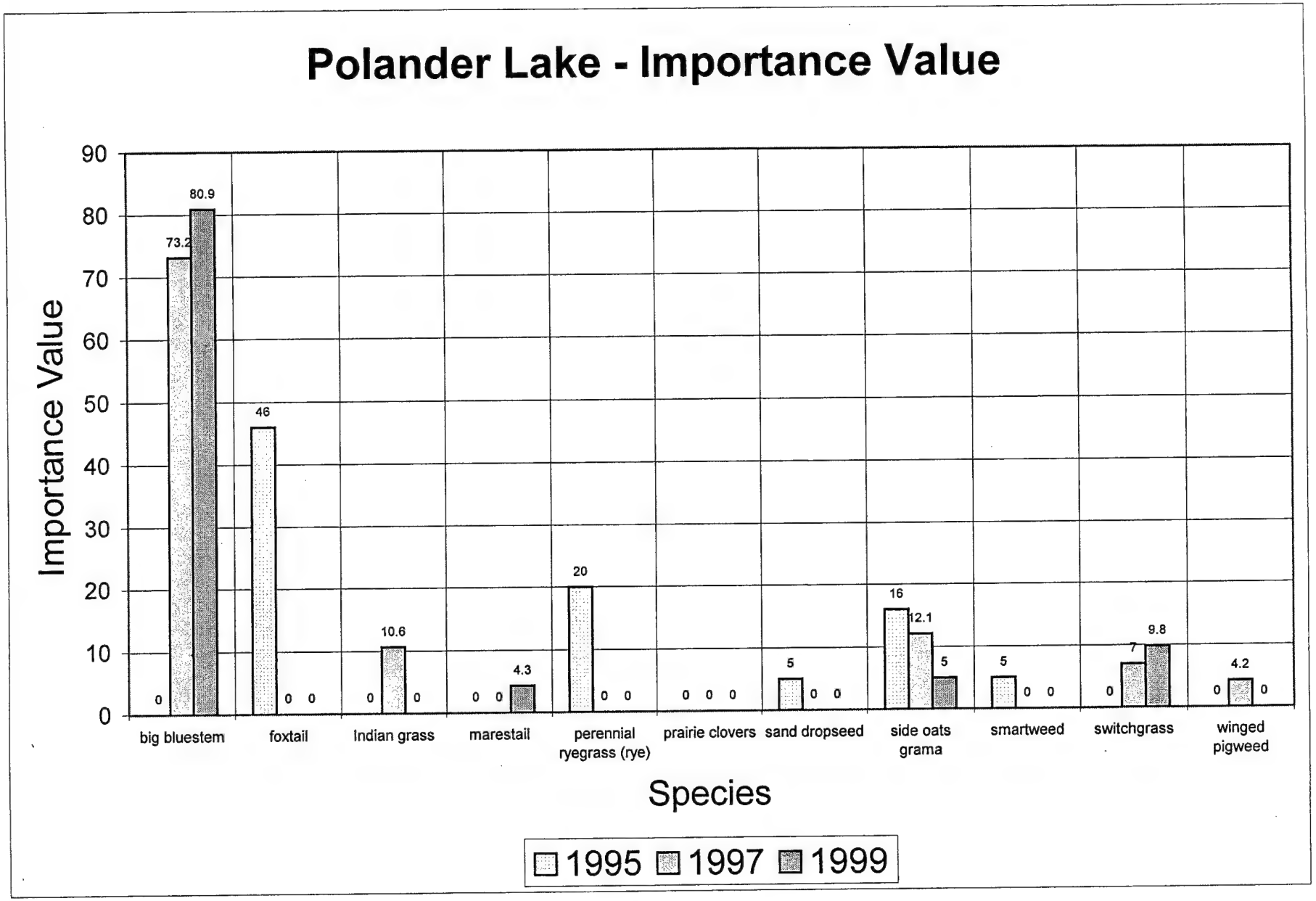
In August 1997, the Robel reading increased to 2.4 decimeters and percent cover to 46%. Big bluestem, side oats grama, and Indian grass were the dominant species. By 1999, switchgrass was a dominant species based on importance value.

Blazing star at the Polander Lake site in August 1999.

SUMMARY TABLE POLANDER LAKE SURVEY DATA

* seeded species	Frequency			Relative Frequency			Dominance			Relative Dominance			Importance Value		
POLANDER LAKE - Disposal Area	Aug-95	Sep-97	Aug-99	Aug-95	Sep-97	Aug-99	Aug-95	Sep-97	Aug-99	Aug-95	Sep-97	Aug-99	Aug-95	Sep-97	Aug-99
* big bluestem		100	90		62.5	75		39	53.5		83.9	86.7		73.2	80.9
foxtail	100			33			15			59			46		
* Indian grass		20			12.5			4			8.6			10.6	
marestail			10			8.3			0.2			0.3			4.3
* perennial ryegrass (rye)	80			27			4			14			20		
* prairie clovers															
* sand dropseed	20			7			1			4			5		
* side oats grama	60	30	10	20	18.8	8.3	3	2.5	1	12	5.4	1.6	16	12.1	5
smartweed	20			7			1			4			5		
switchgrass		10	10		6.2	8.3		1	7		2.1	11.4		7	9.8
winged pigweed	20			7			2			8				4.2	
Average % cover	25	46	62												
Robel (decimeters)	2	2.3	2.4												

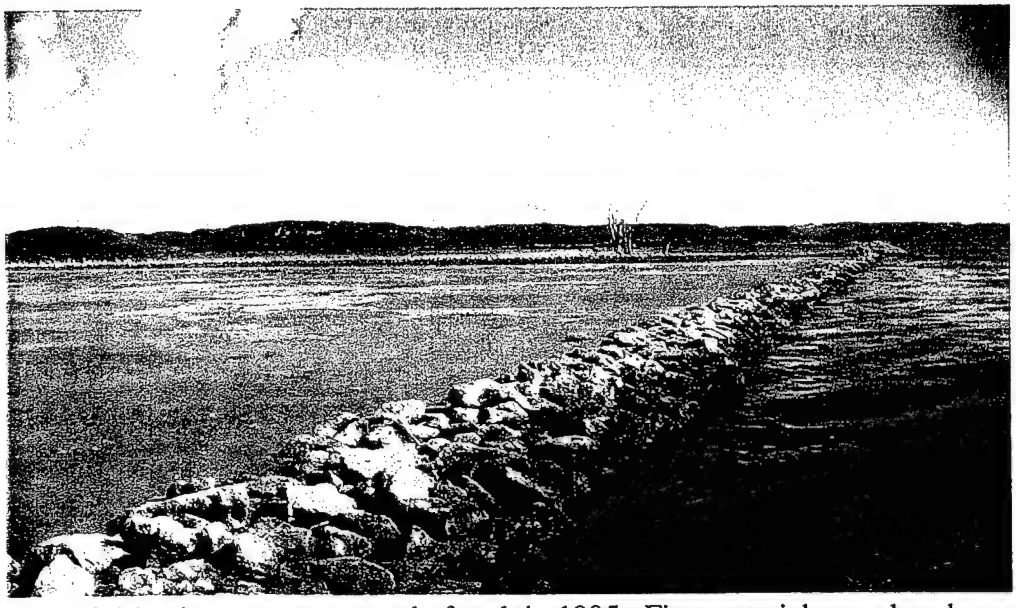

Polander Lake - Dominance
Dominance (% Cover)
60
50
40
30
20
10
0
0
39
53.5
15
0 0
0
4
0
0 0 0.2
4
0 0
0 0 0
1 0 0
3 2.5 1
1 0 0
0 1 7
2 0 0
big bluestem
foxtail
Indian grass
marestail
perennial ryegrass (rye)
prairie clovers
sand dropseed
side oats grama
smartweed
switchgrass
winged pigweed
Species
1995 1997 1999


Polander Lake - Importance Value
Importance Value
90
80
70
60
50
40
30
20
10
0
0
73.2
80.9
46
0 0
0
10.6
0
0 0
4.3
20
0 0
0 0 0
5
0 0
16
12.1
5
5
0 0
0
7
9.8
0
4.2
0
big bluestem
foxtail
Indian grass
marestail
perennial ryegrass (rye)
prairie clovers
sand dropseed
side oats grama
smartweed
switchgrass
winged pigweed
Species
1995
1997
1999

Pool 9 Islands, Pool 9, RM 655.0

Pool 9 Islands was an HREP project in Pool 9 near Lynxville, Wisconsin. A long rock island was constructed in 1995 to encourage the growth of aquatic vegetation. The site consists of the placement of a rock dike about 1 foot above the waterline, with larger rock piles at the corners and at midpoints along the dike. The rock dike is "U" shaped and about 1 mile in length. The larger rock piles initially were capped with fine dredged material. No vegetation activities were conducted at the site. The site was monitored in 1997. At that time, no soil material remained on the rock structures and no vegetation was growing on the island; it was assumed that soil eroded off the rock structures from annual flooding. Aquatic vegetation was growing in the protected areas of the island. No further observations were made, and future monitoring was discontinued.

Pool 9 Islands HREP project constructed in 1995. The island was constructed to protect/enhance aquatic vegetation; note aquatic vegetation growing on protected (left) side of the island.



Pool 9 Islands were constructed of rock in 1995. Fine material was placed on the corners but did not remain after flooding. This September 1997 photo shows abundant aquatic vegetation on the inside of the rock enclosure.

Spring Lake Peninsula, Pool 5, RM 742.8

Vegetation Measures

Spring Lake Peninsula was an HREP project completed in 1995 in Pool 5 near Buffalo City, Wisconsin. The project includes the construction of a closure to improve fishery habitat in Spring Lake. The closure was capped with fine material and drill seeded in June 1995 with the following mixture and mulched.

Species	Seeding Rate
Canada wild rye	5 lbs. PLS/ac.
prairie cordgrass	3 lbs. PLS/ac.
side oats grama	5 lbs. PLS/ac.
switchgrass	2 lbs. PLS/ac.
perennial ryegrass	10 lbs./ac.
prairie clovers	3 oz./ac.

Monitoring Results

A Robel reading of 1.6, 4.9, and 6.9 decimeters was recorded for the area in 1995, 1997, and 1999, respectively. Total percent cover was estimated on each of the quarter-square-meter plots. Vegetation was not very dense in the first growing season. The average cover was 29% in 1995, but increased to 76% in 1997, and 82% in 1999. In 1995 the vegetation cover was fairly uniform over the site, but there were a few pockets of denser growth. Foxtail was the dominant species in 1995. In 1997 foxtail disappeared from the study plots and was replaced by switchgrass as the dominant species. Switchgrass has become more dense over time; the importance of switchgrass increased significantly in 1999. The total percent cover was significantly different at the 0.01 level between 1995 and 1997 but not between 1997 and 1999. See Figures 17 and 18 for a summary of Robel pole readings and percent cover estimates.

The percent cover was estimated for each species on the plot. The frequency, relative frequency, dominance, relative dominance, and importance value were also calculated for each species. On the basis of importance value, the three most important species found on the site were the following:

August 1995	September 1997	August 1999
foxtail	switchgrass	switchgrass
oats	Canada wild rye	big bluestem
bluegrass	big bluestem	Canada wild rye

The Jaccard Index of Species Similarity between 1995 and 1997 was 8. This indicates that the site had very few species in common between the two years. The index increased to 33 for the site between 1997 and 1999. The shorter-lived or early successional species are disappearing.

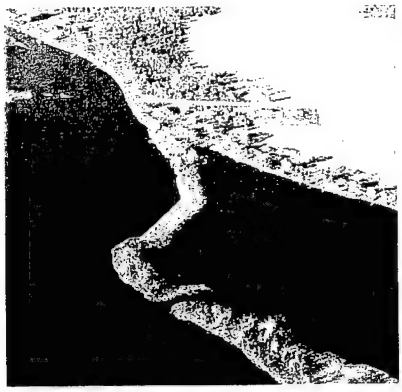
A variety of species are present, but "weedy" species are generally absent. Big bluestem was found on the site, but it was supposedly not a seeded species. It is unlikely that it would have invaded the area naturally and therefore was probably in the original seed mix.

Summary

In 1995, vegetation on the seeded area was growing well and was dominated by foxtail. The Robel readings of 4.6 and 6.9 decimeters in 1997 and 1999, respectively, were very good and exceed the HREP goal of 1.5 decimeters after 2 years of growth. The vegetation density is fairly uniform, with pockets of denser growth. As anticipated from previous monitoring of other sites, the foxtail declined by 1997 and was replaced in dominance by switchgrass.

SPRING LAKE PENINSULA

Spring Lake Peninsula HREP project in Pool 5 at top of photo. A dike was constructed from the mainland to the island, capped with fine sediment, and seeded.



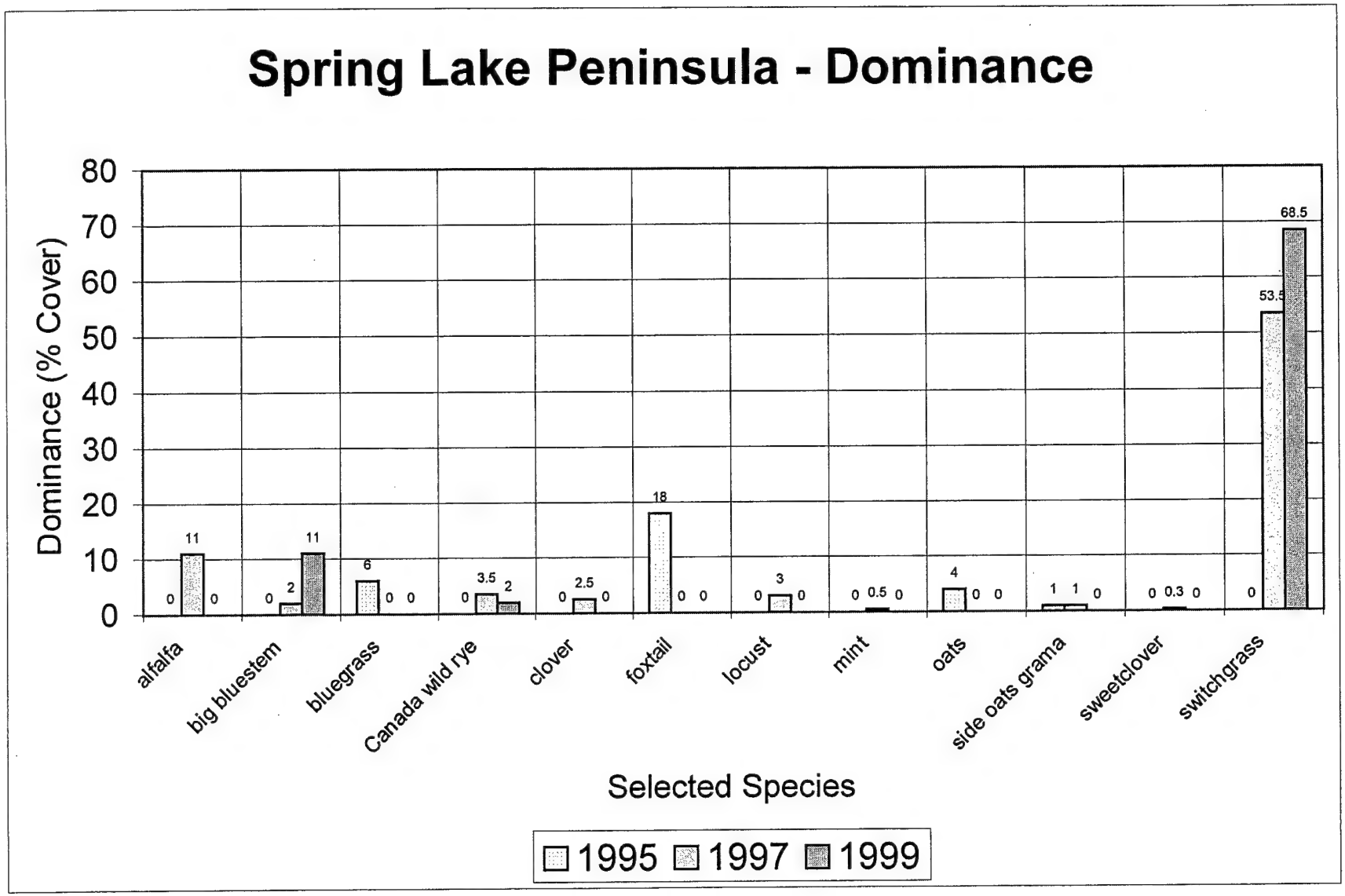
Spring Lake Peninsula HREP project.

Percent cover in August 1995 was 29% and dominated by foxtail and oats. The vegetation was fairly tall but not very dense.

By August 1999, the percent cover had increased to 82%. Foxtail had disappeared and was replaced in importance by switchgrass, big bluestem, and Canada wild rye.

SUMMARY TABLE OF SPRING LAKE PENINSULA SURVEY DATA

* seeded species	Frequency			Relative Frequency			Dominance			Relative Dominance			Importance Value		
SPRING LAKE PENINSULA	8/1995	9/1997	8/1999	8/1995	9/1997	8/1999	8/1995	9/1997	8/1999	8/1995	9/1997	8/1999	8/1995	9/1997	8/1999
alfalfa		40			13.8			11			14.2			14	
big bluestem		30	50		10.3	29.4		2	11		2.6	13.5		6.5	21.4
bluegrass	60			20			6			22			21		
*Canada wild rye		40	20		13.8	11.8		3.5	2		4.5	2.4		9.2	7.1
clover		20			7			2.5			3.2			5.1	
foxtail	100			33			18			61			47		
locust		20			7			3			3.9			5.4	
mint		10			3.4			0.5			0.7			2	
oats	100			33			4			15			24		
*perennial ryegrass															
*prairie clovers															
*prairie cordgrass															
*side oats grama	40	20		13	7		1	1		3	1.3		8	4.1	
sweetclover		10			3.4			0.3			0.4			1.9	
*switchgrass		100	100		34.5	58.8		53.5	68.5		69.2	84		51.9	71.4
Average % cover	29	76	82												
Robel (decimeters)	1.6	4.9	6.9												


Spring Lake Peninsula - Dominance
Dominance (% Cover)
80
70
60
50
40
30
20
10
0
0 11 0
0 2 11
6 0 0
0 3.5 2
0 2.5 0
18 0 0
0 3 0
0 0.5 0
4 0 0
1 1 0
0 0.3 0
0 53.5 68.5
alfalfa
big bluestem
bluegrass
Canada wild rye
clover
foxtail
locust
mint
oats
side oats grama
sweetclover
switchgrass
Selected Species
1995
1997
1999

Peterson Lake, Pool 4, RM 757.8

Vegetation Measures

Peterson Lake was an HREP project completed in 1996 in Pool 4 near Wabasha, Minnesota, and Alma, Wisconsin. The site consisted of dredged material excavated from fish access channels in Peterson Lake. The area was drill seeded in June 1996 with the following mixture and mulched.

Grass Species	Seeding Rate
switchgrass	3 lbs. PLS/ac.
big bluestem	3 lbs. PLS/ac.
little bluestem	3 lbs. PLS/ac.
Indian grass	2 lbs. PLS/ac.
side oats grama	3 lbs. PLS/ac.
sand dropseed	2 lbs. PLS/ac.
perennial ryegrass	20 lbs./ac.
Wildflower Species	
black-eyed Susan	4 oz./ac.
yellow coneflower	1 oz./ac.
rough blazing star	2 oz./ac.
prairie clovers	3 oz./ac.
leadplant	2 oz./ac.
stiff tickseed	3 oz./ac.

At a later date, rootstocks of the following native wildflowers were also planted.

Species	Number of Rootstocks Planted
pale purple coneflower	50
butterfly weed	100
button blazing star	100
oldfield goldenrod	50
prairie onion	50

Monitoring Results

A Robel reading of 2.6 and 4.4 decimeters was recorded for the area in 1997 and 1999, respectively. Total percent cover was estimated on each of the quarter-square-meter plots. The average percent cover was 89% in 1997 and 56% in 1999. This was dense growth and is probably due to the placement of fine material, seeding, and good summer growing conditions. The percent cover was significantly different at the 0.01 level between the two years. See Figures 17 and 18 for a summary of Robel pole readings and percent cover estimates.

The percent cover was also estimated for each species on the plot. The frequency, relative frequency, dominance, relative dominance, and importance value were also calculated for each species. On the basis of importance value, the three most important species found on the site were:

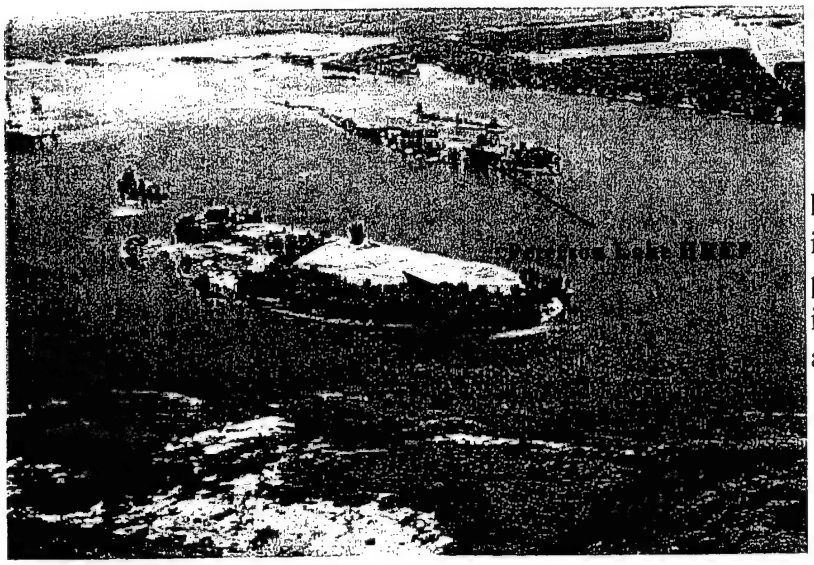
September 1997	August 1999
bentgrass	big bluestem
rye	switchgrass
foxtail	Indian grass

In 1999, the area had dense cover and contained many of the seeded species such as black-eyed Susan, Indian grass, and big bluestem. A variety of species was present including some "weedy" species. Woody species, such as willow and false indigo, are increasing on the site; switchgrass has also increased in importance since 1997. The most common seeded wildflower species present was black-eyed Susan. However, leadplant, side oats grama, little bluestem, and prairie clovers were also observed. The Jaccard Index of Species Similarity between the two years was 45.

Summary

The site appeared to be growing well. The vegetation composition was distributed fairly evenly over the area; however, in 1999 there were areas that exhibited about 25% cover. The bluestems and Indian grass were more common on the north end of the site, and black-eyed Susan was scattered in clumps around the area. 1n 1999, there were many seeded species present, good overall percent cover, and a Robel reading that exceeded the HREP project goal of 1.5 decimeters after 2 years of growth.

PETERSON LAKE



Peterson Lake HREP project site in Pool 4. Fine sediments were placed on the site and drill seeded in June 1996 with native grasses and forbs.

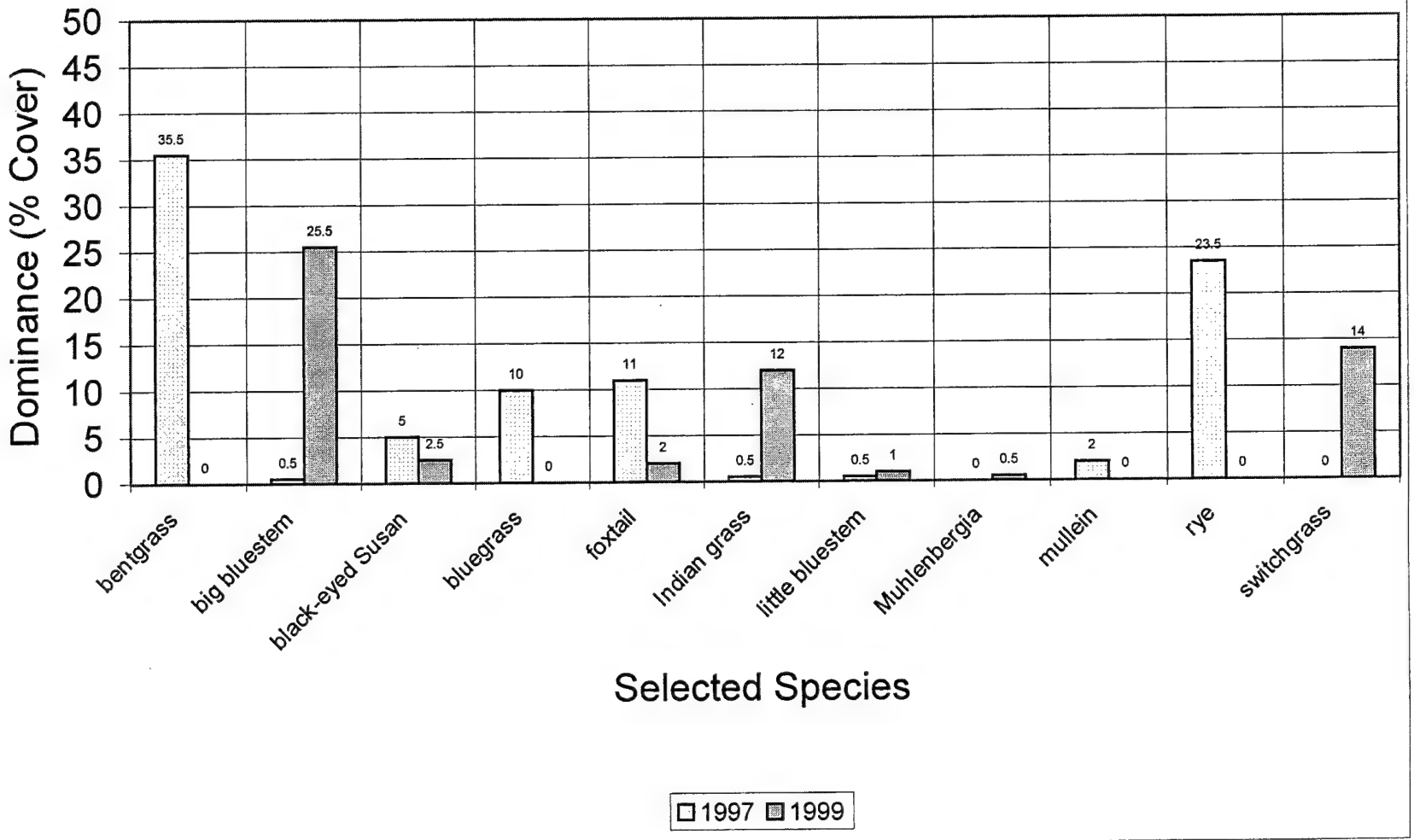
In August 1997, the site had a Robel reading of 2.6 decimeters and 89% cover. Black-eyed Susan, mullein, and foxtail were abundant.

By August 1999, the percent cover declined to 56% and the Robel reading increased to 4.4 decimeters. The seeded species dominated the site. The dominant species were big bluestem, switchgrass, and Indian grass. Black-eyed Susan was still present.

SUMMARY TABLE OF PETERSON LAKE SURVEY DATA

		Frequency		Relative Frequency		Dominance		Relative Dominance		Importance Value	
*	seeded species										
	PETERSON LAKE	Sep-97	Aug-99	Sep-97	Aug-99	Sep-97	Aug-99	Sep-97	Aug-99	Sep-97	Aug-99
	bentgrass	100		25.6		35.5		40.1		32.9	
*	big bluestem	10	60	2.6	28.6	0.5	25.5	0.6	44.4	1.6	36.5
*	black-eyed Susan	40	10	10.3	4.8	5	2.5	5.6	4.4	8	4.6
	bluegrass	30		7.7		10		11.3		9.5	
	foxtail	90	10	23.1	4.8	11	2	12.4	3.5	17.8	4.1
*	Indian grass	10	50	2.6	23.8	0.5	12	0.6	20.9	1.6	22.3
*	leadplant										
*	little bluestem	10	10	2.6	4.8	0.5	1	0.6	1.7	1.6	3.2
	Muhlenbergia		10		4.8		0.5		0.9		2.8
	mullein	10		2.6		2		2.3		2.4	
*	prairie clovers										
*	rough blazing star										
*	rye	90		23.1		23.5		26.6		24.8	
*	sand dropseed										
*	side oats grama										
*	stiff tickseed										
*	switchgrass		60		28.6		14		24.4		26.5
*	yellow coneflower										
	Average % cover	89	56								
	Robel (decimeters)	2.6	4.4								

Peterson Lake - Dominance



Wabasha Prairie, Pool 5, RM 752.5

In September 1998, 500,000 cubic yards of dredged material was pumped from the Grand Encampment Dredged Material Placement Site in lower Pool 4 to empty the containment area for future use in maintaining the 9-foot navigation channel. Dredged material (sand) was placed onto what was called the Wabasha Prairie located near Kellogg, Minnesota. The 29-acre site was then covered with 4 to 5 inches of organic soil hauled by truck from a nearby property. In October 1998, the site was seeded to winter wheat and mulched. On April 26 and 27, 1999, the site was seeded to native grasses and wildflowers by U.S. Fish and Wildlife Service refuge personnel using a Truax and Brillion drill. The following species and quantities were seeded. Refuge personnel monitor the site several times a year; therefore, only cursory measurements were made for this report.

Grass Species	Seeding Rate
big bluestem	15 lbs. PLS/ac.
little bluestem	20 lbs. PLS/ac.
side oats grama	15 lbs. PLS/ac.
switchgrass	5 lbs. PLS/ac.
Indian grass	15 lbs. PLS/ac.
Canada wild rye	5 lbs. PLS/ac.

Wildflower Species	Seeding Rate
early sunflower	1.3 oz./ac.
pale purple coneflower	1.3 oz./ac.
prairie blazing star	1 oz./ac.
stiff goldenrod	1 oz./ac.
compass-plant	1 oz./ac.
rattlesnake master	0.7 oz./ac.
Maximilian sunflower	0.3 oz./ac.
lead plant	0.3 oz./ac.
black-eyed Susan	1 oz./ac.
yellow coneflower	1.3 oz./ac.
purple prairie clover	1.3 oz./ac.
roundheaded bushclover	0.7 oz./ac.
partridge pea	0.7 oz./ac.
hoary vervain	0.3 oz./ac.
western sunflower	0.3 oz./ac.
showy tick trefoil	0.3 oz./ac.
Ohio spiderwort	0.3 oz./ac.

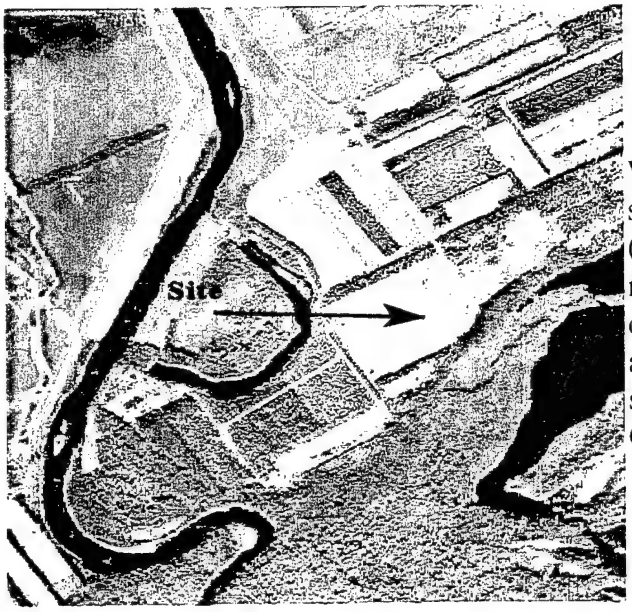
The site was mowed on August 10 and 11, 1999, to reduce competition from weeds. Grasses and other vegetation were growing, according to casual observations on August 25, 1999. A formal monitoring program has not yet been undertaken. Casual observations in August 1999 showed good growth on the site.

The site was visited in August 2000. Formal plots to determine frequency and dominance were not taken because the site was mowed the preceding month. Only total percent cover and Robel measurements were taken. These may not reveal very much due to the mowing. Total percent cover averaged 34% with an average Robel reading of 1.2 decimeters.

Although no formal survey plots were taken in 2000 because of the recent mowing, a partial species list was prepared while walking through the site. The following species were observed:

partridge pea
foxtail
black-eyed Susan
blue vervain
yellow coneflower
marestail
brome
alfalfa
birds-foot trefoil
little bluestem
daisy fleabane
Indian grass
horsemint
sorrel
ragweed
Canada wild rye
timothy
tick trefoil
side oats grama
big bluestem
sunflower
prairie clover
switchgrass
mullein
white champion
blazing star

WABASHA PRAIRIE



Wabasha Prairie vegetation site in Pool 4. The site was used for disposal of dredged material (sand) from emptying the Crats Island dredged material placement site. Dredged material was capped with topsoil from an adjacent farm field and seeded in 1999 to big and little bluestem, side oats grama, switchgrass, Indian grass, Canada wild rye, and various prairie forbs.

August 1999, four months after seeding with grasses beginning to grow. The site was recently mowed.

Photo taken in August 2000. The site was mowed in July to help reduce the growth of weeds and clover. Many seeded species were observed on the site. Field measurements are somewhat misleading due to the mowing but percent cover averaged about 34 percent with a Robel reading of 1.2 decimeters.

Wildcat Landing, Pool 8, RM 688.0

Wildcat Landing was a vegetation project conducted by the Wisconsin Department of Natural Resources in Pool 8 near Brownsville, Minnesota. Seven plots were seeded on May 22, 1981, with 7 to 15 lbs. PLS/acre as follows:

Plot Number	Seed Mixture
1	Blackwell switchgrass
2	prairie dropseed and switchgrass
3	big bluestem, little bluestem, switchgrass, Indian grass
4	big bluestem, little bluestem, Indian grass
5	sand bluestem, Indian grass
6	switchgrass (var. Nebraska 28)
7	control - not seeded

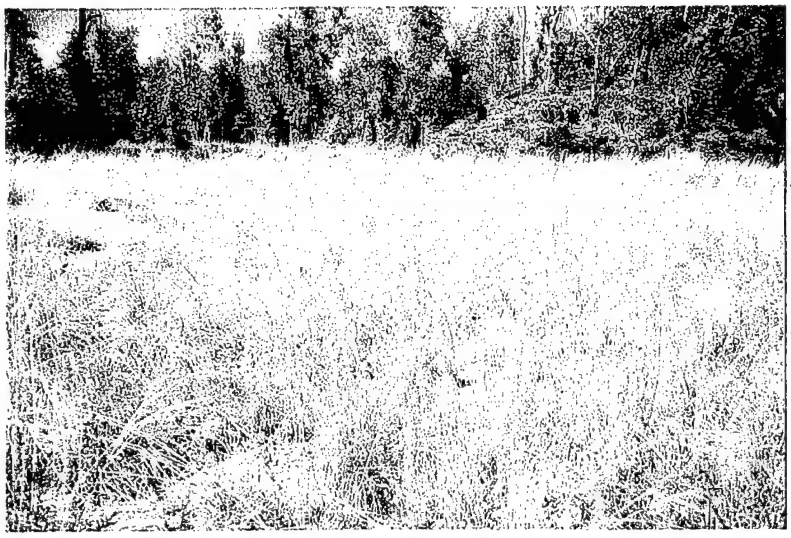
These sites have been visited by Corps of Engineers and Fish and Wildlife Service personnel but have not been systematically monitored. Observations in August 1985 revealed that vegetation at all seven plots was growing well, with both planted and naturally occurring species. The switchgrass and Indian grass plantings appeared to be doing the best.

The percent cover appeared to be slightly higher here than at other sand areas identified in this report. This may be due to the longer period of establishment. The site is also closer to the water table and more protected than most of the other revegetated sand sites, such as Lost Island.

WILDCAT LANDING

Wildcat Landing vegetation site in Pool 8. Seven plots, located along this line, were seeded to native grasses by the Wisconsin Department of Natural Resources in May 1981.

Photo taken in August 2000. Percent cover and composition do not seem to have changed much over time. Seeded species are still dominant.



These plots were not monitored. This photo was taken in May 1985. The switchgrass and Indian grass plantings appeared to be doing the best.

Photo taken in August 1985. This is the Indian grass plot. Percent cover seemed to be similar to other seeded sand areas reviewed in this report.

Dresbach Island, Pool 7, RM 704.6

Dresbach Island is located in Pool 7 near Dresbach, Minnesota, and was the site of two experiments. The first involved several small sand areas that were revegetated with grasses; however, these sites were never monitored.

The second experiment involved the effect of sedimentation on the survival of trees. Sedimentation is a natural process on the Upper Mississippi River. During high flow, sediment is picked up and deposited as the water velocity decreases. Usually the deposition is a thin layer of material, averaging a few inches, and occurring in the spring of the year. In an effort to determine the effects of sedimentation on floodplain trees, dredged material (sand) was placed on experimental plots established on Dresbach Island. The floodplain forest on the island was typical of the area. The overstory consisted of elm, cottonwood, black willow, green ash, box elder, silver maple, and river birch. The understory vegetation was sparse and dominated by nettle and poison ivy. Two plots were established and all trees greater than 4 inches in diameter were recorded.

The placement area was used in the fall of 1978. Because of the small amount of dredging required in 1978, the depth of fill material was not as great as was anticipated. A range of zero to 6.3 feet of sediment had been placed around the trees. The mean depth of fill was 2.1 feet.

The study site was monitored in August 1979, and although a few trees were recorded as dead, the vast majority were in good to moderate condition. The site was monitored again in September 1984. A number of dead elm were observed which could have been killed by Dutch elm disease. Sediment placement of 2 to 4 feet of sand had little effect on the trees. A core sample taken from one tree showed increased growth since sediment placement. Thicker material or the placement of fine sediment (silt or clay) could have different results.

Conclusions from this study included the following:

1. Fill material may not have been to a depth great enough to significantly affect the growth of the trees. Zero to 4 feet of sediment seemed to have had little effect on the floodplain forest.

2. Fill activities may have limited effects since the trees are accustomed to some sedimentation due to natural flooding. Adventitious buds form on many of the floodplain species, thereby improving their chances of survival.

3. Coarse porous material like sand may adversely affect trees less than fine material.

4. In order to minimize adverse effects, material should not be placed directly next to trees, and a situation should not be created where water could be ponded around the base of the tree.

DRESBACH ISLAND SEDIMENT STUDY

Dresbach Island sediment test plots in Pool 7. Two areas of trees were marked and monitored to assess tree mortality from dredged material placement.

In 1978, dredged material (sand) was placed to a depth of 0 to 4 feet in the floodplain forest of elm, ash, willow, cottonwood, and silver maple. No appreciable tree mortality was observed when this photo was taken in September 1984.

September 1984. This photo shows one of the trees marked in 1978 with nails and flagging at about 9 feet from the original ground surface. Tree diameter was measured at this height. An occasional dead elm was observed, possibly from Dutch elm disease. One tree core showed increased growth after sediment was placed.

SUMMARY AND CONCLUSIONS

A variety of vegetation sites has been monitored to determine the success of plantings and to guide future vegetative efforts. Monitoring was usually conducted in the fall (see Table 1). Percent cover was estimated for each site with random quarter-square-meter plots along a transect. Robel readings estimated the height-density relationship of vegetation. Percent cover was estimated for individual species in the plot, as were frequency, relative frequency, dominance, relative dominance, and importance value. (See summary table and graphs following each site discussion.) A list of species observed while walking over the sites was compiled to indicate all species present. Summaries of percent cover, Robel readings, and importance values are presented in Tables 2, 3, 4, 5, and 6.

In summary, establishment of vegetation or seeding of dredged material placement sites and HREP projects was successful. Vegetation helped reduce site erosion, improved the aesthetic appearance, and provided valuable wildlife habitat.

The most notable conclusion from the study was that fine material increased the density of vegetation (both planted and naturally occurring). Percent cover of vegetation on sites capped with fine material was usually in the 50% to 80% range, with Robel readings exceeding the 1.5 decimeter goal for HREP projects. In contrast, percent cover of vegetation on sand sites ranged from zero to about 50%, with the majority of values at the lower end of this range. See Tables 2 and 3.

Switchgrass was recorded as the most important species on vegetation sites twice as often as any other species; it was followed in importance by side oats grama and sand dropseed (see Tables 4, 5, and 6 and associated figures). Switchgrass and sand dropseed were seeded on many sites and also occur naturally on sand deposits along the river. Switchgrass was often very dense and tall; at some sites, the high density of switchgrass may have reduced the abundance of other vegetation by shading or other means.

Foxtail, a weedy species which was not seeded, often dominated many of the more recently constructed HREP sites soon after seeding. It was assumed that foxtail seeds were in the seed mixture or contained in the fine sediments. In most cases, the abundance of foxtail declined over time and was replaced by the seeded species.

The monitoring effort could not explain a major question: Why are some vegetation sites (Boomerang Island, Cold Springs, and the southern part of Horseshoe Island) quickly converting from grasses to dense herbaceous and woody vegetation, while other sites (the northern part of Horseshoe Island, Weaver Bottoms, Peterson Lake, and Indian Slough) of similar or older age are maintaining their grass cover? One logical reason would be their proximity to other woody vegetation, like Island 58 which is adjacent to bottomland forest. However, an exception is the Jackson Island vegetation site which is also located within bottomland forest but is maintaining grass cover. There are other methods of propagule dispersal that could influence the vegetative composition such as dispersal by wind, water and birds.

Table 2. SUMMARY OF PERCENT COVER AT VEGETATION STUDY SITES

Site	6/1982	8/1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Cold Springs														95			91			
Finger Lakes																				
Disposal Area															79		96		98	
Access Area																			66	
Indian Slough																				
South end															41		84		82	
North end																			96	
Onalaska Islands																				
Broken Gun										96	78	52	83	9	65				61	
Burned															71					
Not burned															58					
Cormorant										91	73	71	87	27	71				57	
Burned															89					
Not burned															59					
Arrowhead										89	78	55	71	60	65				62	
Rosebud Island											90								87	
Peterson Lake																	89		56	
Polander Lake															25		46		62	
Pool 8 Islands																				
Horseshoe Overall											40	74	66	51	61					
Horseshoe East											34	78								
Horseshoe West											46	70								
Boomerang													26	62	55					
Island A																				32
Island B																			89	56
Island C																				36
Island D1																				47
Island D2																				36
Island E1																			36	46
Island E2																			28	55

Table 2. SUMMARY OF PERCENT COVER AT VEGETATION STUDY SITES (Continued)

Site	6/1982	8/1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Spring Lake															29		76		82	
Jackson Island																				
Fine Topsoil						92	77	38	91	92							80			
Sand Topsoil						38	48	23	34	38							52			
Weaver Bottoms																				
Swan Is. Overall								4	54	100	66	59	77		51					
Swan Is. Top - unburned											47									
Swan Is. Top-burned											86									
Mallard Is. Top								0	33	30	64	39	32		21					
MN 10-Top								13	13	10	24	11	12		12					
MN 11-Top								1	51	65	56	62	69		64					
MN 12-Top								2	15	5	17	13	18		13					
MN 13-Top								1	39	50	37	40	65		24					
WI 10								1	56	40		48	61		44					
Lost Island																				
Seeded Area	6	33	12	16	20	38	45	42	42	50										
Control Area	1	8	16	8	4	9	20	17	12	10										
Crosby Island																				
Seeded Area					1	4	6	9	16	14										
Control Area					4	1	0	1	2	2										
Teepeeota Point																				
Fine Sediment					20	20	16	14	14	16										
Control Area					4	8	10	0	8	6										
Island 42								68	92					77						
Island 58						100	100	100	100	100										
Wabasha Prairie																				34
Wabasha Gravel Pit						15	11	16	12	21										

Table 3. Summary of Robel Height/Density Readings at Vegetation Study Sites

SITE	Year									
	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Cold Springs				3.5			9.9			
Finger Lakes										
Disposal Area					3.4		6.5		5.9	
Access Area									2.8	
Wabasha Prairie										1.2
Indian Slough										
South end					1.9		7.2		6.9	
North end									9.2	
Onalaska Islands										
Broken Gun	3.7	3.3	5.2	1	3.7				3.3	
Burned					5.8					
Not burned					1.6					
Cormorant	4.1	3.1	4.3	1	2.3				5.5	
Burned					3.2					
Not burned					1.7					
Arrowhead	2.1	2.1	2.8	3.4	3.5				1.8	
Rosebud Island	3.5								2.2	
Peterson Lake							2.6		4.4	
Polander Lake					2		2.3		2.4	
Pool 8 Islands										
Horseshoe East	1.3	2.1	2.6	2.9	5.2					
Horseshoe West	1.4	2								
Boomerang			0	2.2	4.8					
Island A										1.8
Island B									6.8	2.4
Island C										3.6
Island D1										2.2
Island D2										2.1
Island E1									1.3	1.3
Island E2									1	1.7
Spring Lake					1.6		4.9		6.9	
Jackson Island										
Fine Topsoil							6.4			
Sand Topsoil							0.7			
Island 42				2.7						
Weaver Bottoms										
Swan Island Top - unburned	1.8	2.6	3.1		3.5					
Swan Island Top-burned	8.8									
Mallard Island. Top	1.6	1.8	0.6		0.5					
MN 10-Top	0.6	0	0		0					
MN 11-Top	1.7	1.2	2.5		1.1					
MN 12-Top	0.2	0	0		0.1					
MN 13-Top	0.8	0.7	1.9		0.3					
WI 10		2	1		1.4					

Table 4. Number of Times Species Ranked by Importance Value

	Number of Times Species Listed by Importance Value In					
	Top 4	1 or 2	1	2	3	4
alfalfa	8	7	2	5	0	1
barnyard grass	3	1	1	0	1	1
big bluestem	10	9	7	2	0	1
bindweed	1	0	0	0	0	1
birds-foot trefoil	1	1	0	1	0	0
black-eyed Susan	9	3	0	3	4	2
blazing star	1	0	0	0	1	0
bluegrass	18	12	3	9	4	2
brome	4	4	1	3	0	0
Canada wild rye	23	12	8	4	6	5
carpetweed	4	0	0	0	0	4
clammyweed	1	0	0	0	1	0
clover	19	10	7	3	2	7
crown vetch	1	1	1	0	0	0
dandelion	1	0	0	0	0	1
evening primrose	2	0	0	0	0	2
foxtail	16	10	8	2	2	4
foxtail barley	1	0	0	0	0	1
hop clover	1	0	0	0	0	1
Indian grass	7	2	1	1	4	1
jointweed	6	5	2	3	1	0
lambsquarters	2	0	0	0	1	1
little bluestem	3	0	0	0	0	3
marestail	12	3	1	2	4	5
mint	1	0	0	0	1	0
Muhlenbergia	5	4	2	2	1	0
mustard	1	0	0	0	0	1
perennial rye	10	9	2	7	0	1
prairie clover	1	0	0	0	0	1
purple loosestrife	3	1	0	1	2	0
purple sandgrass	7	4	0	4	3	0
quackgrass	2	0	0	0	1	1
ragweed	3	0	0	0	1	2
reed canary grass	22	7	2	5	7	8
rice cutgrass	1	0	0	0	0	1
sand dropseed	21	11	7	4	5	5
sedge	4	0	0	0	1	3
side oats grama	42	17	7	10	18	7
smartweed	5	1	0	1	2	2
switchgrass	48	32	21	11	8	8
thickspike wheatgrass	5	5	3	2	0	0
thistle	1	0	0	0	0	1
Virginia wild rye	4	0	0	0	3	1
wild oats	5	4	1	3	1	0
winged pigweed	3	1	1	0	1	1
witchgrass	1	1	0	1	0	0
wormwood	5	2	1	1	2	1

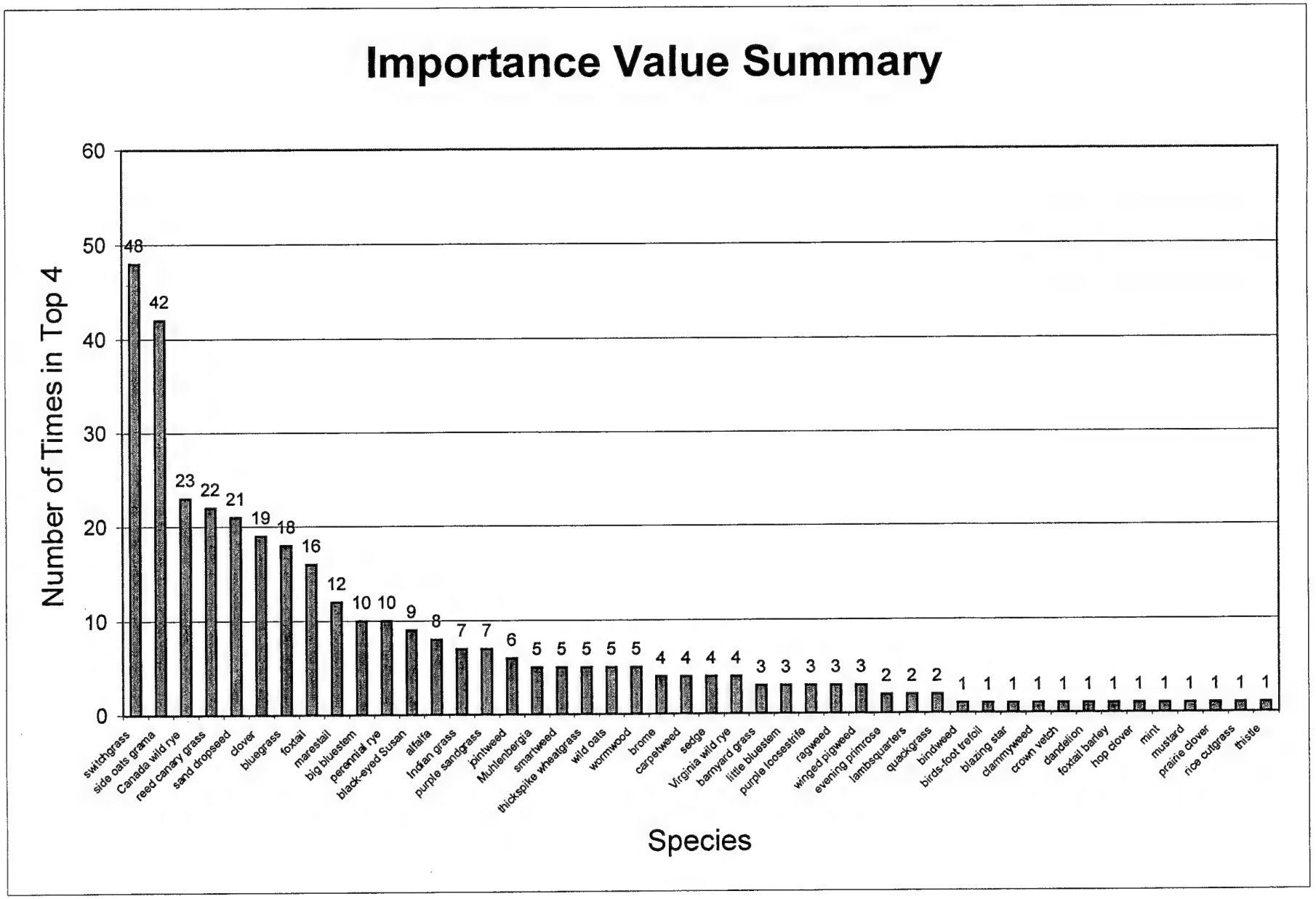


Figure 19. Summary of Importance Value calculations. Number of times a species was identified as being in the top 4 importance value.

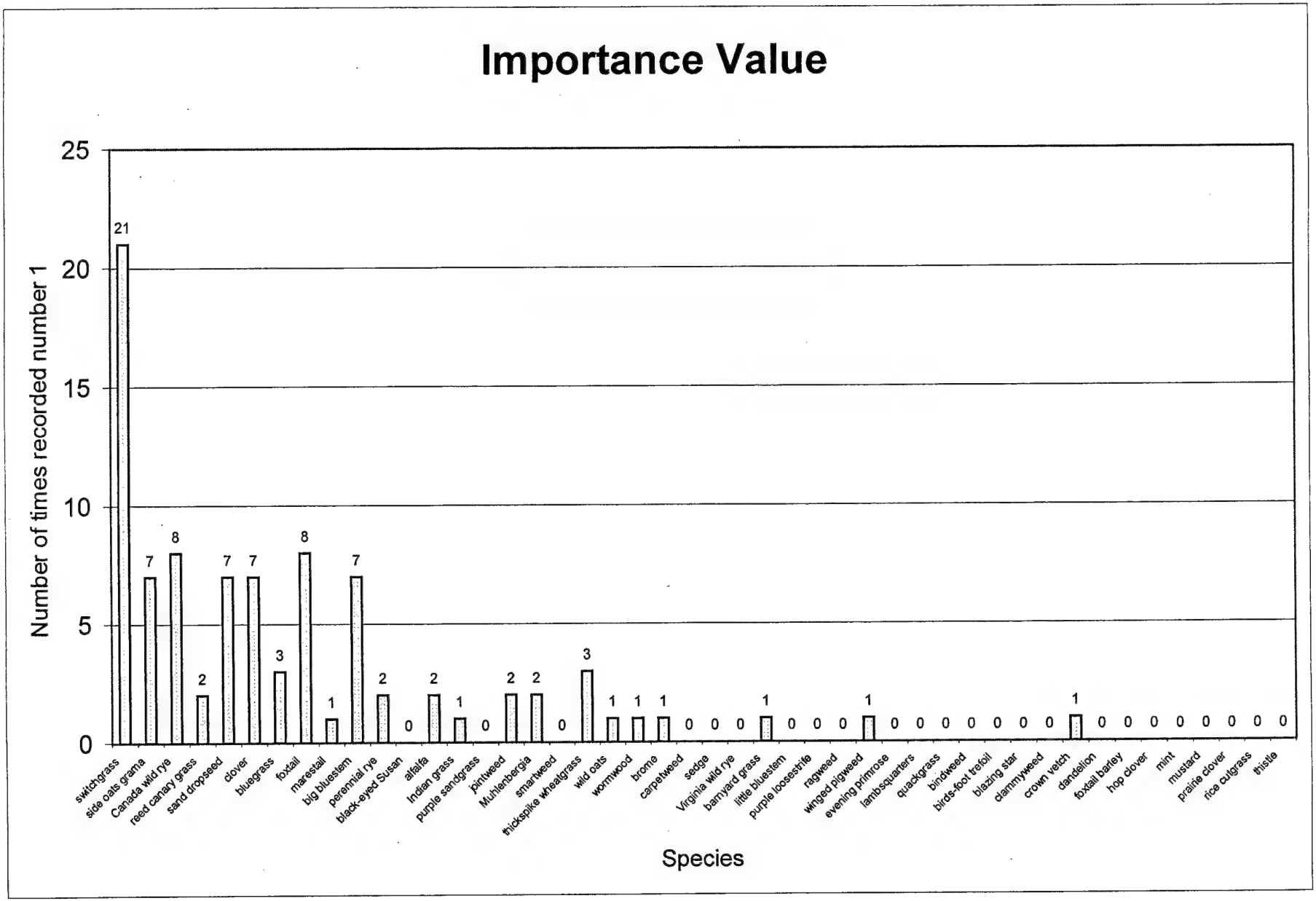


Figure 20. Number of times species was recorded as first based on Importance Value.

Table 5. Number of Times Species Ranked In Top Four Importance Value by Year

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	Total
alfalfa	4	1	0	0	0		1		0	1	7
barnyard grass	2	0	1	0	0		0		0	0	3
big bluestem	0	0	1	0	1		3		5	0	10
bindweed	0	0	0	0	0		0		1	0	1
birds-foot trefoil	0	0	0	1	0		0		0	0	1
black-eyed Susan	0	1	0	0	2		1		3	2	9
blazing star	0	0	0	0	0		0		1	0	1
bluegrass	0	3	3	4	4		1		3	0	18
brome	0	0	0	1	0		0		1	2	4
Canada wild rye	3	4	2	2	4		1		2	4	22
carpetweed	1	1	1	0	1		0		0	0	4
clammyweed	0	0	0	0	1		0		0	0	1
clover	2	5	5	2	5		0		0	0	19
crown vetch	0	0	0	0	0		0		1	0	1
dandelion	0	0	0	1	0		0		0	0	1
evening primrose	0	0	0	0	1		0		1	0	2
foxtail	1	0	1	0	4		2		4	5	17
foxtail barley	0	0	0	0	1		0		0	0	1
hop clover	1	0	0	0	0		0		0	0	1
Indian grass	0	1	1	0	0		2		3	0	7
jointweed	2	2	2	0	0		0		0	0	6
lambsquarters	0	0	0	0	1		0		1	0	2
little bluestem	0	0	0	0	1		1		1	0	3
marestail	3	1	1	0	3		0		4	0	12
mint	0	0	0	0	0		0		1	0	1
Muhlenbergia	0	0	0	0	0		1		3	1	5
mustard	0	0	0	0	1		0		0	0	1
perennial rye	3	1	1	2	2		1		0	0	10
prairie clover	0	0	0	0	0		0		1	0	1
purple loosestrife	0	0	0	1	1		1		0	0	3
purple sandgrass	2	1	2	0	2		0		0	0	7
quackgrass	0	2	0	0	0		0		0	0	2
ragweed	1	0	0	0	1		0		1	0	3
reed canary grass	2	3	3	4	6		1		2	1	22
rice cutgrass	0	0	0	0	0		1		0	0	1
sand dropseed	5	5	5	0	4		0		2	0	21
sedge	0	1	1	1	1		0		0	0	4
side oats grama	6	8	6	3	9		2		4	4	42
smartweed	2	0	2	1	0		0		0	0	5
switchgrass	6	6	6	5	9		4		10	2	48
thickspike wheatgrass	2	3	0	0	0		0		0	0	5
thistle	0	0	1	0	0		0		0	0	1
Virginia wild rye	0	0	0	0	0		0		0	3	3
wild oats	2	0	0	0	1		0		2	0	5
winged pigweed	1	1	0	0	0		1		0	0	3
witchgrass	0	0	1	0	0		0		0	0	1
wormwood	0	1	1	0	3		0		0	0	5

Table 6. Average Importance Value by Species by Year

Species	1991	1992	1993	1994	1995	1997	1999	2000	Average
alfalfa	24	3	1	2	2	14		44	13
alsike clover				17					17
barnyard grass	16		2		4		5		7
bentgrass						33			33
big bluestem			48		18	43	51		40
bindweed							2		2
birds-foot trefoil				29					29
black-eyed Susan		25	5		8	6	6	24	12
blazing star							6		6
blue vervain				1	2				2
boneset					1				1
brome				52		5	27	35	30
bulrush	3								3
burnweed					2				2
Canada wild rye	22	29	11	24	23	6	14	24	20
carpetweed	10	7	10		8				9
clammyweed	2				8				5
clover	8	14	33	6	14	3			11
cocklebur	3				1				2
cottonwood							4		4
crown vetch							67		67
daisy fleabane		1	2		2				2
dandelion	1			7					4
dock	1		1						1
dogbane	5	2			2	2			3
evening primrose	1			1	6				3
foxtail	4	1	2	1	20	13	23	27	11
foxtail barley					4				4
goldenrod				1					1
green needlegrass		17							17
hop clover	3								3
horsetail		2	3		2				3
Indian grass		3	6			10	35		14
jointweed	14	27	36		4				20
knotweed				2					2
lambsquarters	1	1			8		5		4
little bluestem			1		4	9	3		4
locust						5			5
lovegrass	4								4
marestail	15	5	18	1	5		6		8
milkweed							2		2
mint						2	6		4
moonseed						3			3
Muhlenbergia							15	41	28
mullein						2			2
mustard					3				3
oats	20				24		26		23
partridge pea							3		3
paspalum					6	9			8
pennycress		4							4
plantain				1	2				2
Poa sp.		16	17	21	31	10	33		20
prairie clover							3		3
purple loosestrife				8	12	33			18
purple sandgrass	12	12	22		21				17
quackgrass		1			4		2		2
ragweed	6	3	1		8		3		4
reed canary grass	14	2	11	18	12	8	28	4	12
rice cutgrass						12			12
river bulrush						2			2
rye	21	1	64	46	29	25			31
sand dropseed	16	21	24	2	31	2	6		15
sedge	2	5	5	4	14	5			6
side oats grama	26	28	16	20	20	21	7	20	20
smartweed	11	1	14	5	5	4	6		7
sorrel			2				1		2
sumac					1				1
sunflower			1		1			10	4
switchgrass	38	31	33	28	23	28	31	9	28
thistle		1	2		1				1
unidentified broadleaf			3				6		4
unknown grass		8	22		22				17
Virginia wild rye								16	16
velvet leaf	3								3
water horehound					2				2
wheatgrass	18	32							25
white champion	3								3
wild grape	8								8
winged pigweed	33	10				4			16
witchgrass	4		8			2	2		4
wormwood		16	9		21				15

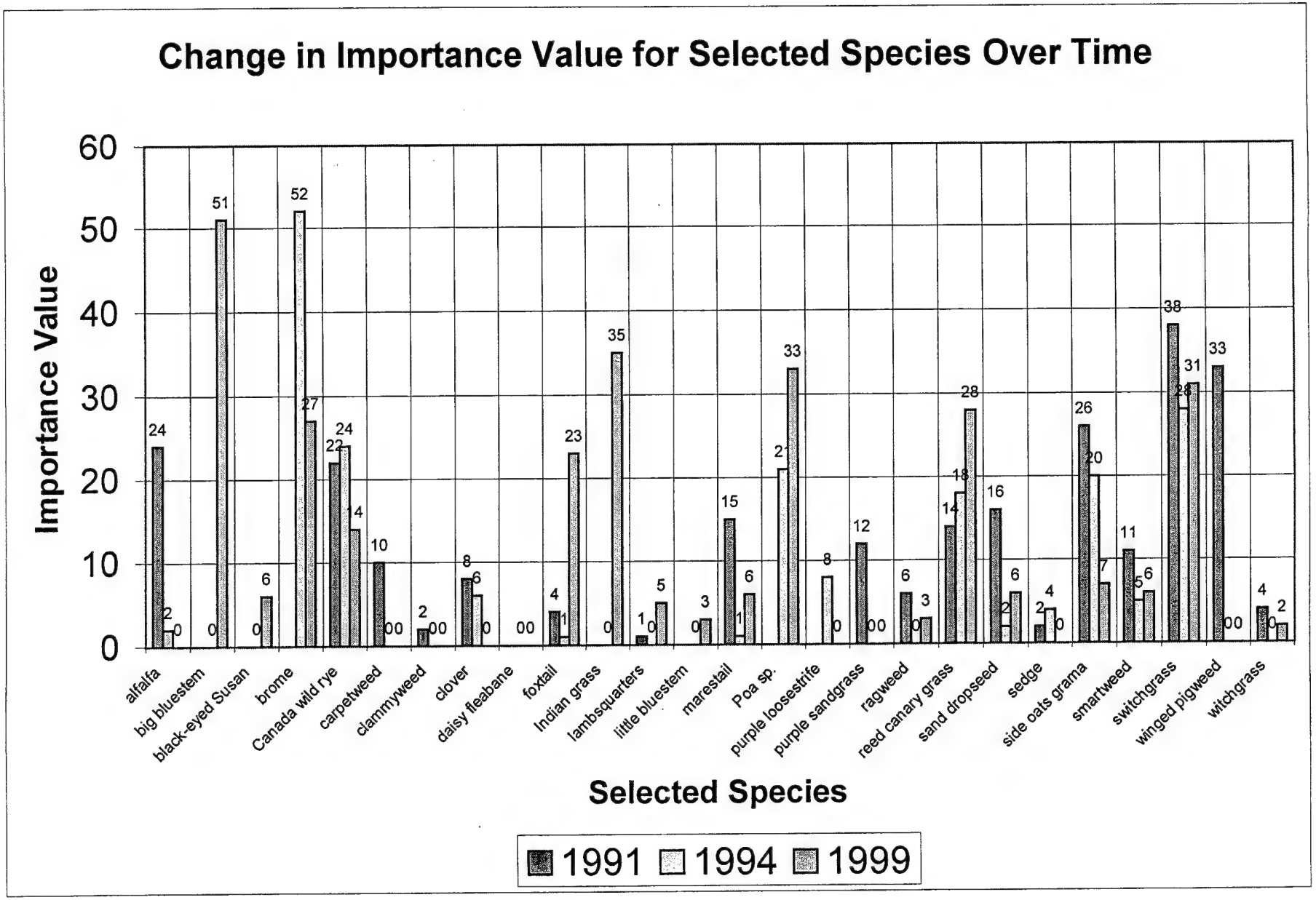


Figure 21. Change in Importance Value for selected species over time.

Part of the reason may also be whether the site was seeded with grasses. An adequate amount of fine material on the site may favor establishment and maintenance of seeded grasses over time and substantially delay succession to woody vegetation. Without seeding, vegetation of fine material is dependent on its natural seed bank. Perhaps at Island 58, which was not seeded, the fine material contained mostly cottonwood seed which germinated and became established. An interesting observation can be made for Mallard Island which was capped with fine sediment but not seeded; there, predominantly weeds became established with no appreciable woody vegetation to date. The difference between Jackson Island (woody cover) and Mallard Island (herbaceous cover) may be due to their unique seed banks, since neither site was seeded.

It also seemed that vegetation sites that were higher in elevation, had fine sediments, and were seeded (Swan Island and selected side channel closures in Weaver Bottoms) also maintained their grass cover over time. Sites that had fine sediments and were seeded but were constructed to a lower elevation (Boomerang Island, Cold Springs, Spring Lake, Lake Onalaska Islands) may favor herbaceous and woody vegetation over time. If true, it could be anticipated that sites such as Phase 2 of the lower Pool 8 HREP project would quickly convert to herbaceous and woody cover over time in comparison to other sites (Weaver Bottoms islands and side channel closures) that were constructed to a higher elevation above the river.

Other possible reasons could be the depth of the fine material or the proportion of coarse and fine material. Observations in these areas are also variable and based on limited analysis. Some sites with deep fine material maintained their grass cover and some did not and vice versa. On the basis of limited analysis, sites with a smaller proportion of fines (more coarse material) maintained their grass cover.

In order to answer outstanding questions, these observations require additional investigation including vegetation monitoring, soil analysis, and correlation with site elevation if resource managers desire to maintain grass habitat over time on vegetation sites. Maybe changes in project design (e.g., amount of fine material, proportion of fine material, species selection, or island elevation) and/or management activities (e.g., prescribed burning, fertilization, mowing, or second seedings) are needed to help maintain the grassland habitat and reduce the amount of herbaceous and woody material. Historically, fire (either natural or human caused) helped control woody growth in open and prairie areas; prescribed burns may be required at some sites if grass cover is desired.

To help evaluate the success of plantings over time, Table 7 shows species initially planted at each study site (excluding second seedings or subsequent plantings of various rootstocks) and their occurrence (present or absent) based on quarter-square-meter plot data for the last time sites were monitored. Depending on the site, this could represent over 12 years of growth. Because a species was identified as "absent" from a site does not necessarily mean it was not growing there. Many species were identified during the "walk through" observation of the site; however, the less common ones often were not numerous enough to be sampled in quarter-square-meter plots. Therefore, species that were identified as "present" on sites in Table 7 were usually abundant.

Table 7. Species Planted and Long-Term Growth Response by Site Based on Plot Data for Last Year Site was Monitored

SPECIES	Sand Sites Capped With Fine Material																								Sand Sites									
	Indian Slough	Peterson Lake	Finger Lakes	Wabasha Prairie	Island 42	Weaver Bottoms				Spring Lake	Polander Lake	Onalaska Islands			Rosebud Island	Pool 8, Phase 1		Pool 8, Phase 2							Cold Springs	Jackson Island	Wabasha Gravel Pit	Lost Island	Weaver MN 12	Crosby Island	Pool 8, Phase 2				Jackson Island
						Swan	MN 11	MN 13	WI 10			Broken Gun	Cormorant	Arrowhead		Horseshoe	Boomerang	A	B	C	D1	D2	E1	E2							D1	D2	E1	E2	
alfalfa																		Y			Y													
American beachgrass																													Y	Y	Y	Y	Y	
big bluestem	Y	Y	Y	P					Y		Y									N						Y		N		N				Y
birds-foot trefoil					Y																													
black-eyed Susan	Y	Y	Y	P					Y											Y														
blazing star	N	N	Y	P					N																									
bluegrass					Y																													
bluejoint reedgrass																				N														
brome					Y										Y			Y			Y														
Canada wild rye			Y	P		Y		N	Y	Y		N	N	N		Y	Y		Y			Y	Y	Y	N			N		Y				
clovers			N																						N		N	N						
compassplant				P																														
coneflowers	N	N	N	P																								N		N				
crown vetch																																		
goldenrods				P																														
green needlegrass								N																										
hoary vervain				P																														
Indian grass	Y	Y		P		N					N									N						Y								N
leadplant	N	N	N	P																														
little bluestem	N	Y	Y	P		Y	Y															N	N	N				N		N				
oak RPM trees	Y										Y																							
oats			N															N	N	N	N	N	N	N										
Ohio spiderwort				P																														
partridge pea				P																														
prairie clovers	N	N	Y	P						N									N			N	N	N									
prairie cordgrass						N				N										N														
prairie dropseed	N									N																								
rattlesnake master				P																														
rice cutgrass								Y																										
rye	N	N			N					N	N	N	N	N	N	N	N								N		N	N		N				
sand bluestem																			N															
sand dropseed		N	N		N	N			N		N								N			N	N	N				Y	Y					
sand reedgrass						N																												
side oats grama	N	N	Y	P		Y	Y		Y	N	Y	Y	N	Y		Y	N		Y			Y	Y	Y		Y			N		N				Y
stiff tickseed	N	N	N																															
sunflowers				P					N										N			N	N	N										
switchgrass	Y	Y	Y	P		Y	Y			Y		Y	Y	Y	Y	Y	Y		Y	Y					Y	Y	Y	Y		N				Y
thickspike wheatgrass									N							Y	N																	
tick trefoil				P																														
timothy					N													N			N				N									
Virginia wild rye																				Y														

LEGEND:

N planted but not observed on the surveyed plots the last time the site was monitored
Y planted and observed on the surveyed plots the last time the site was monitored

P species planted; no survey plots taken

Note: no survey plots taken at beachgrass plantings

Some observations can be made from Table 7:

1. Switchgrass grew on both sand and fine material sites. It was found in samples from 95% (19 of 20) of the sites where it was seeded.

2. Sand dropseed grew better on sandy sites. It was found in samples from sand sites (100%) but not from any fine material sites.

3. Side oats grama grew on both types of sites but was found more often on sites capped with fine sediment (72%) than bare sand (33%).

4. Successful establishment of Canada wild rye was variable, but it became a component of established vegetation on both fine material (67%) and sand (50%) sites.

5. Black-eyed Susan grew well on sites capped with fine material; it was found in samples from all seeded sites.

6. Rye or oats planted as a nurse crop did not persist; none were found in samples from 23 sites seeded.

7. American beachgrass grew well on all sand sites where it was planted.

8. Successful establishment of big bluestem, little bluestem, and Indian grass was variable but better on sites with fine material (62%) than bare sand (17%).

9. Alfalfa was a dominant species at sites planted with trees. It forms a dense cover at least during the first couple of years after planting. It may also have some effect on providing vole and mouse habitat. These mammals chew on the bark of planted trees and have a detrimental effect on survival.

Other factors that varied among vegetation sites included the depth of fine material, the height above the river, and the age (number of growing seasons) (see Table 8). The depth of fines indicated in Table 8 is an estimate, as no post-project measurements were taken. Also, the actual depth may be highly variable. For example, at Indian Slough, the fine material could be from 1 to over 10 feet in depth. We chose to group sites that were greater or less than 6 feet in height from the river, assuming that sites less than 6 feet in height may provide better moisture conditions for vegetation.

Although variations occurred among and within sites, it is possible to draw some insights concerning the long-term establishment of vegetation, site elevation from the river, and depth of fine material (Table 8):

1. Sites of similar seeding mixture (prairie grasses and forbs) and site conditions (capped with more than 1 foot of fine material) were compared to evaluate the influence of age (number of growing seasons since the site was last monitored) on average percent cover. The findings

Table 8. Site Characteristics and Most Dominant Species Based on Plot Data for Last Year Site was Monitored

SPECIES	Sand Sites Capped With Fine Material																														Sand Sites				
	Indian Slough		Peterson	Finger	Lakes	Wabasha	Island	Weaver Bottoms					Spring	Polander	Onalaska Islands			Rosebud	Pool 8, Phase 1		Pool 8, Phase 2							Cold	Jackson	Wabasha	Lost	Weaver	Crosby	Jackson
	South	North	Lake	Disposal	Access	Prairie	42	Swan	Mallard	MN 11	MN 13	WI 10	Lake	Lake	Broken Gun	Cormorant	Arrowhead	Island	Horseshoe	Boomerang	A	B	C	D1	D2	E1	E2	Springs	Island	Gravel Pit	Island	MN 12	Island	Island
alfalfa																					1S			1S										2S
big bluestem	1S	1S	1S									2S	2N	1S															1S					
birds-foot trefoil							2S																2S			3N								
black-eyed Susan	2S				3S							3S																						
blazing star					3S																													
bluegrass							3S								2N	2N	1N																	
brome							1S											2S			2S			2S							3N			
Canada wild rye												1S	3S						1S	1S		3S	1N	3N	1S	2S	2S					2S	
clammyweed								3N																										
clovers									1N			1S																						
crown vetch																		1N																
foxtail		2N																				2N				1N	1N							
Indian grass	3S		3S		1S																								2S					
lambsquarters										3N																								
marestail				3N					2N					3N																				
mint				3N																		1N												
Muhlenbergia																																		3N
paspalum																				3N							2N							
purple loosestrife																														2N		2S		
purple sandgrass																																		
ragweed								3N																										
reed canary grass															1N	3N			3N									3N						
rice cutgrass																																	3N	
Russian thistle									1N		2N																			3N	1S	1S		
sand dropseed																														1N		3S		
sedge																	3S								2S		3S							1S
side oats grama				2S	2S			2S		1S		1S										3S						1S			2S			
switchgrass			2S	1S				1S	3N	2S			1S	2N	3S	1S	2S	3S	2S	2S														
unknown grass											3N										3N		3N		3N									
Virginia wild rye																																	1N	
winged pigweed											1N																							
wormwood																																		
Depth of Fine Material (ft)	>1	>1	<1	>1	>1	<1	>1	<1	<1	<1	<1	<1	>1	>1	<1	<1	<1	>1	<1	>1	>1	>1	>1	>1	>1	>1	>1	>1	<1	0	0	0	0	0
Height Above River (ft)	>6	>6	>6	<6	<6	>6	<6	>6	>6	>6	>6	>6	<6	>6	<6	<6	<6	>6	<6	<6	<6	<6	<6	<6	<6	<6	<6	<6	<6	>6	>6	>6	>6	<6
Percent Fines (silt/clay)	-	-	-	-	-	-	14	27	32	-	-	-	-	-	37	38	51	-	42	36	-	-	-	-	-	-	-	66	-	0	0	0	0	0
Date Seeded	5/94	5/94	6/96	6/94	6/94	4/99	6/87	6/88	7/88	7/88	7/88	7/88	6/95	10/94	6/90	6/90	6/90	6/90	6/91	6/93	6/99	5/99	6/99	5/99	6/99	5/99	6/99	6/94	5/84	9/85	5/82	7/88	5/85	5/84
Date Last Monitored	8/98	8/99	8/99	8/99	8/99	8/00	8/94	8/95	8/95	8/95	8/95	8/95	8/99	8/99	8/99	8/99	8/99	8/99	8/95	8/95	8/00	8/00	8/00	8/00	8/00	8/00	8/00	9/97	9/97	8/90	8/90	8/95	8/90	9/97
Growing Seasons	6	6	4	6	6	2	8	8	8	8	8	8	6	5	10	10	10	10	5	3	2	2	2	2	2	2	2	4	14	5	9	8	6	14
Percent Cover in Last Year	82	96	56	82	66	34	77	51	21	64	24	44	82	62	61	57	62	87	61	55	32	58	36	47	36	46	55	91	80	21	42	13	14	52
Robel Reading in Last Year	6.9	9.2	4.4	5.9	2.8	1.2	2.7	3.5	0.5	1.1	0.3	1.4	6.9	2.4	3.3	5.5	1.8	2.2	5.2	4.8	1.8	2.4	3.6	2.2	2.1	1.3	1.7	9.9	6.4	-	-	0.1	-	0.7

LEGEND:

1 first most dominant plants found on surveyed plots the last time the site was monitored
2 second most dominant plants found on surveyed plots the last time the site was monitored
3 third most dominant plants found on surveyed plots the last time the site was monitored

S species seeded
N species not seeded

suggest that it may take several (three to six) growing seasons before vegetation reaches a desired/maximum density (Figure 22). On the basis of this relationship, sites with less than four growing seasons were eliminated, leaving 25 sites for further evaluation below.

2. Average percent cover was highest on vegetation sites that were capped with more than 1 foot of fine material (81%), followed by sites that had less fine material (53%) and bare sand (28%).

3. Legumes and other forbs were more likely to become established on sites with fine material; 19% of dominant species lists for fine material sites contained herbaceous vegetation (12 species) compared to 13% for sand sites (2 species). Of the 12 dominant species on fine material sites, only 4 were planted (birds-foot trefoil, black-eyed Susan, blazing star and prairie clovers). Both dominant herbaceous species on sand sites (Russian thistle and winged pigweed) established naturally.

4. The depth of fine material at vegetation sites also influenced the establishment of seeded species; a higher percentage of seeded species were dominant on sites with more than 1 foot of fine material (68%) than on sites with less fine material (56%).

5. The composition of the fine material/soil may also influence vegetation. With one exception, fine material sites with more than 35% silt/clay had a higher average percent cover than sites with a lesser amount.

6. The height of the vegetation site above the river did not appear to influence average percent cover of vegetation. On sites capped with more than 1 foot of fine material, average percent cover was 80% for sites higher than 6 feet and 82% for lower sites. On sites capped with less than 1 foot of fine material, average percent cover was 64% for sites higher than 6 feet and 43% for lower sites.

7. Although variable, some of the lower elevation sites contained more herbaceous and woody vegetation.

8. Although not seeded, foxtail was found on some sites, especially in the earlier years. It was probably present in the seed mix as weed seed or invaded the site from outside seed sources. Reed canary grass, another species not seeded, was also found on some sites, especially those lower in elevation.

As a result of the monitoring activities, a number of conclusions can be drawn based on soil type, planting practices, and management techniques. These are summarized below.

Soil Type

Sand

1. Weedy species dominate unseeded sand areas. The more common species are winged pigweed and clammyweed. Grass species are slow to invade sandy areas and will likely be

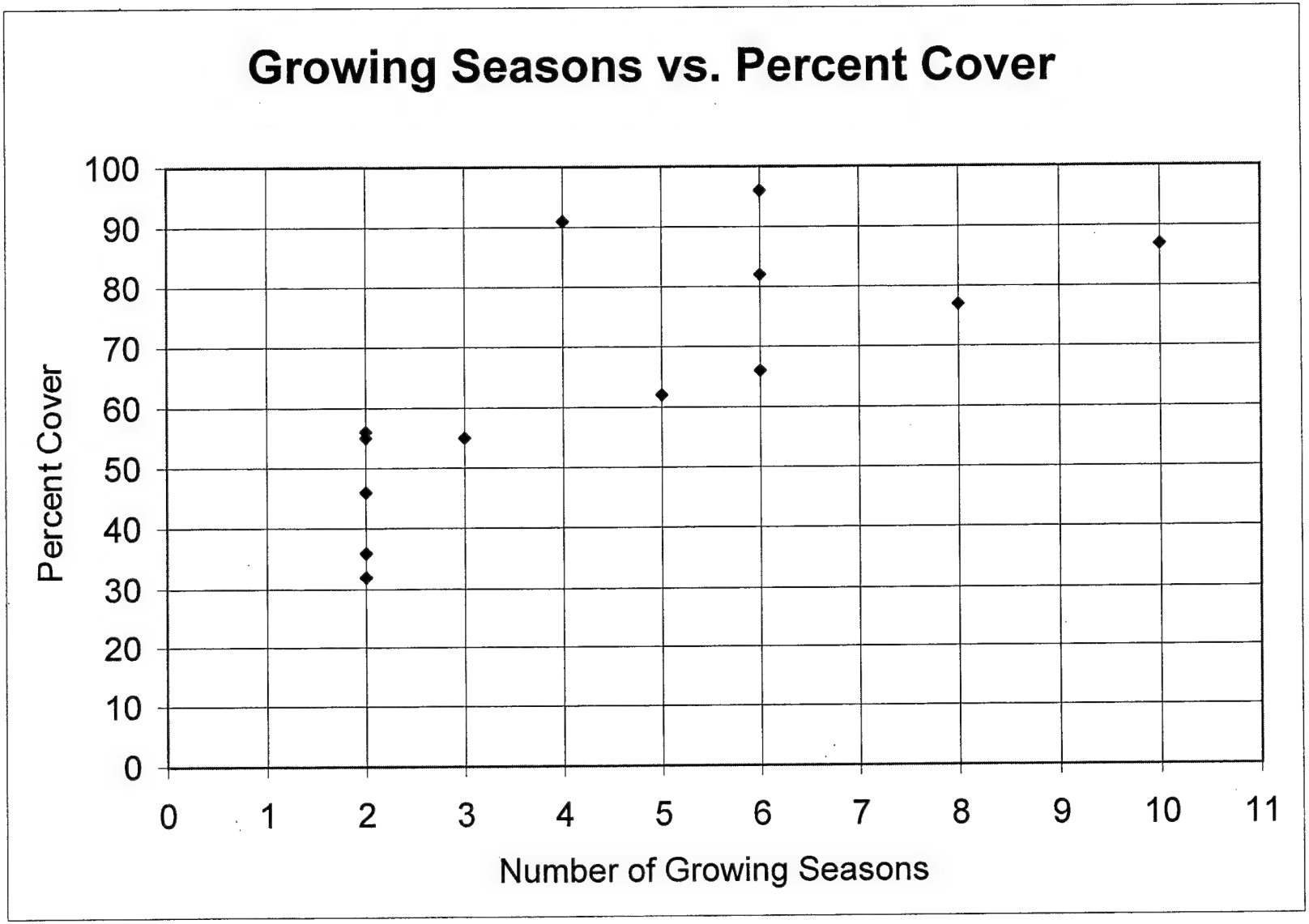


Figure 22. Average percent cover in relation to the number of growing seasons since last monitored for vegetation sites capped with more than 1 foot of fine material.

limited to species such as sand dropseed and purple sandgrass which are common species on dredged material (sand) placement sites along the river.

2. It is very difficult to establish desirable vegetation on bare sand. A number of years is required to establish a reasonable cover even with seeding.

3. Bare sand can be vegetated, but the maximum percent cover attainable appears to be about 50%; however, sand material rarely exceeds 40% cover even after many years.

4. Disturbance of sites, especially sandy areas, should be avoided because it can eliminate the vegetation and set it back to an early successional stage. This includes disturbance by all-terrain vehicles, construction equipment, and excessive recreation use.

5. The best species for seeding bare sand appear to be sand dropseed, side oats grama, switchgrass, and Canada wild rye. It may not be necessary to seed sand dropseed because it naturally invades sandy and disturbed areas.

6. American beachgrass stolons expand rapidly and grow well on bare sand. However, they do not appear to tolerate summer inundation of 3 weeks or more. American beachgrass will grow on the higher side slopes of containment areas. It appears to be best to plant these sites, as natural colonization of the side slopes from lower areas is slow.

Fine Sediment

1. The technique of using fine sediment and seeding of sand structures significantly increases the density of resulting vegetation.

2. The height and density of vegetation, as reflected by Robel pole readings, are highest on areas that were seeded and received fine material.

3. Seeded Canada wild rye, side oats grama, switchgrass, and sand dropseed establish quickly on sites with fine sediment.

4. Flowering herbs can be planted in combination with grasses on sites with fine sediment to add an aesthetic feature to the treatment.

5. All of the particle size analysis for capped sites contained at least 13% fine material. All of the sites produced a good vegetative cover. Therefore, it appears that 15% fine material in the surface soil is sufficient to result in successful establishment of vegetation.

6. The thickness of the fine material seems to affect the amount of erosion -- too much fine sediment makes it difficult to incorporate with the sand and can lead to erosion problems if placed on side slopes. The fine material should be mixed with the underlying sand or contain sufficient coarse material to allow for aeration and water infiltration. Eight inches of fine sediment appears to be too much for disking with standard farming equipment, and 1 inch too

little for establishment of topsoil for vegetation. All of the sites evaluated in this report had at least 0.5 foot of fine material. Six inches of fine material should be the minimum used for capping.

7. The use of an irrigation sprayer does not appear to be a practical method of placing enough fine material on top of sand. It appeared that the irrigation sprayer would be a slow process and would not be effective. It is not known if an irrigation sprayer could build up an adequate layer of fine material for capping (at least 6 inches). If there is other equipment that pumps less water and more solids, it may be worth trying.

8. Fine material by itself without seeding may or may not result in a dense vegetative cover. Results have been variable and inconclusive. Usually the placement of fine material is expected to result in a fairly good cover, even though it is expected to be more "weedy" type species. Vegetation is partly dependent on the seed bank contained within the fine sediment, soil moisture characteristics, and dispersal of propagules by wind, water, and birds.

9. It appears that the capping material should contain some coarse material (sand) to allow for infiltration and prevent the formation of a hard, dry surface material. In areas where the depth of fine material is over 1 foot and it cannot be incorporated with the underlying sand, there should probably be a requirement on the percentage of fine material used for topsoil. Phase 2 of the Pool 8 Islands HREP Project specified that fine material spread on the island must have at least 40% of the material pass through a 200 sieve (40% fines). It did not specify an upper percentage. Similar specifications were not developed for other sites, and the results of the monitoring were not sufficient to make a recommendation concerning the percentage of fine material. Future projects could include a range of percentages, particle size analysis, and monitoring to help determine the optimal mix.

10. Areas have been fertilized and legumes planted in an effort to improve soil fertility and the growth of vegetation. This has not been monitored, and results are inconclusive.

Planting and Management

1. Seeding is necessary if particular grass species are desired.

2. The establishment of native grass species has been somewhat variable. Species such as big bluestem, little bluestem, Indian grass, and prairie cordgrass are usually slower to establish. Depending on conditions, native species have become established immediately at some of the HREP sites. The reason for the variability in establishment is not known.

3. Where switchgrass is planted, many times it becomes a dominant component within 5 years. It has been observed that dense stands of switchgrass can develop and in some cases result in suffocation of subsequent years' growth. The switchgrass can become matted and cover the ground surface to a degree that prohibits the growth of vegetation. A prescribed burn, at least temporarily, reduces the surface material and allows the growth of vegetation. It may be desirable to reduce the seeding rate for switchgrass to 1 pound or less per acre.

4. Wildflowers included in the seed mixture have become established and are doing well, although they are a minor component, in many cases. The best species appear to be black-eyed Susan, partridge pea, blazing star, leadplant, and prairie clovers.

5. Equipment is easiest to maneuver on slopes less than 1 on 3. Steep slopes can be revegetated but it may be desirable to stabilize the toe with riprap, groins, or bio-engineering methods.

6. It does not appear to be worthwhile to seed sand reedgrass, thickspike wheatgrass, or green needlegrass. They are difficult to establish.

7. Planting of rice cutgrass stolons does not appear to be practical.

8. Wild oats is a good nurse crop. However, it also attracts geese which may cause overgrazing of vegetation, especially in the early stages of seed germination.

9. Weedy species persist for a number of years, even on seeded sites.

10. Mulch is helpful but may not be necessary, especially on level areas. Mulch may be desirable on side slopes greater than 1 on 4.

11. Watering is not necessary and may be undesirable if it cannot be maintained, because the vegetation would establish growth characteristics based on unnatural moisture conditions.

12. One-time use of fertilizer does not appear to be necessary. Planting of legumes may be desirable.

13. It may be desirable to cut back on the seeding rate of switchgrass to 1 lb./ac. or less.

14. Tree planting is successful. Tree tubes and mats are recommended. Oak Root Production Method trees, cottonwood, and willow plantings appear to have been the most successful.

15. Native and hybrid willow appear to do well from cuttings. False indigo and dogwood cuttings were not as successful.

16. The use of prescribed fire should be closely monitored in tree plantings. Oaks have been damaged by prescribed burns. Burning enhances the growth of the seeded grass species and increases density, at least temporarily. Weedy species also increase in density. Switchgrass may be set back and reduced in density by burning.

17. The use of exotics or non-native species, American beachgrass and hybrid willow, or non-local seed sources should be evaluated on the basis of the objectives for the site. The long-term effects of possible genetic variation and invasive species may be a consideration in the management objectives or site goals.

Conclusions from Dresbach Sediment Placement Study

1. Zero to 4 feet of sediment seemed to have had little effect on the floodplain forest. Fill placement may not have been to a depth great enough to produce effects.

2. Fill activities may have limited effects, since the trees are accustomed to some sedimentation due to natural flooding. Adventitious buds form on many of the floodplain species, thereby improving their chances of survival.

3. Coarse porous material such as sand may have less effect than fine material.

4. In order to minimize adverse effects, do not place material directly next to a tree and do not create a situation where water could be ponded around the base of the tree.

RECOMMENDATIONS

From the results of monitoring the sites over the years, some recommendations on species and site preparation can be made on the basis of the site conditions and the goals of vegetation activities. The following are general recommendations that may be modified based on the objectives and personal feelings of the project designers. General recommendations are not appropriate for all situations. Each site has to be evaluated on its own vegetation goals and soil conditions. Depending on the goals and decisions of the project managers, the selection of local or regional ecotypes or exotics may or may not be desirable.

General

1. Fertilization and watering should not be initiated unless they can be continued.

2. Drill seeding is recommended.

3. Mulch is recommended, especially on the steeper slopes.

4. A nurse crop of rye or oats is recommended.

Sand Sites

1. Species that appear to do well and usually become established include American beachgrass, Canada wild rye, sand dropseed, side oats grama, and switchgrass.

2. Species to avoid include crown vetch, prairie cordgrass, and most of the clovers.

3. Species that may become established include big bluestem, little bluestem, and Indian grass.

Sand Sites Capped With Fine Material

1. The thickness of fine material is somewhat questionable. Six inches appears to be the minimum. Depending on the elevation of the site in relation to water, a thicker cap of fine material with a high proportion of fines may encourage a dense growth of woody and herbaceous cover. In some situations, a thick cap of fine clay with little coarse (sand) material may become hard and not allow water to infiltrate, causing erosion.

2. Species that usually become established on sand sites capped with fine material include big bluestem, little bluestem, Indian grass, black-eyed Susan, bluegrass, brome, Canada wild rye, side oats grama, switchgrass, and other forbs.

3. Species to avoid on fine material sites include sand reedgrass, timothy, wheatgrass, sand dropseed, prairie dropseed, and some of the forbs.

4. It may be desirable to reduce the amount of switchgrass used in the seed mixture. In some situations, switchgrass becomes dominant at the expense of other species.

5. It appears that mowing or burning should be part of the long-term management plan to help control species composition and vegetation density.

6. Oak Root Production Method trees appear to do well on sand sites capped with fine material. Burning of these sites should be controlled to minimize damage to the trees.

7. Willow, both cuttings and natural, become well established at lower elevations.

Based on our monitoring results, the following table can be used as a guide to site management but should not be the only determination. There are other factors such as moisture conditions of the site and other management goals or long-term management activities such as burning or mowing that may determine what species to plant and site preparation to conduct. Also, some species in combination with others may or may not be desirable, depending on the management goals.

Site Management Goal	New or Existing Sand Site	New or Existing Sand Site Capped With Fine Sediment
Native Prairie With Dense Nesting Cover	No. Seeded prairie grasses will take several years to become established. Vegetation density will be limited compared to typical prairie habitat.	Yes. Dense native prairie vegetation (grasses such as Indian grass, big and little bluestem, side oats grama, switchgrass, and Canada wild rye) can be established on sites capped with fine sediment. The site may need periodic maintenance such as burning or mowing to enhance growth and eliminate unwanted species. If desired, native trees such as white oak can also be planted on fine sediment to establish Oak Savanna habitat; suggest using oak Root Production Trees and planting them in Tubex tubes to increase survival and growth. Prairie forbs such as prairie clovers, purple coneflower, early sunflower, blazing star, black-eyed Susan, leadplant, and partridge pea can also be established on these sites. For grasses, site preparation should include drill seeding and establishment of a nurse crop (oats, etc.). It is not necessary to water or fertilize.
Scattered Grasses With Sand Openings	Yes. It will take several years for seeded vegetation to become established. Once established, vegetation should require minimal maintenance. Prairie grasses such as Indian grass, big and little bluestem, side oats grama, switchgrass, and Canada wild rye can be seeded. Sand dropseed occurs naturally on sand deposits on the Upper Mississippi River; it can be planted but will likely occur anyway. Site preparation should include drill seeding; establishment of a nurse crop (oats, etc.) is preferable but may not be necessary. It is not necessary to water or fertilize.	No. Vegetation (seeded grasses or natural vegetation) will quickly become dense with no sand openings.
Erosion Control	Yes. It will take several years for seeded grasses to become established on sand sites and provide effective erosion control. However, maintenance of established vegetation should be minimal. Vegetation will not be dense. An exception is American beachgrass which forms a relatively dense monoculture. However, it is a non-native species and takes several years to spread by rhizomes. If possible, the site should be capped with fine sediment and seeded with desirable species to increase vegetation density and erosion control benefits. Willow cuttings can also be planted along shoreline areas for bank stabilization.	Yes. Seeded grasses will quickly provide dense cover for erosion control. Site preparation should include drill seeding, mulch (especially on steep slopes), and establishment of a nurse crop (oats, etc.). Willow cuttings can also be planted along shoreline areas for bank stabilization. Fine sediment can also be allowed to revegetate naturally but may become weedy with undesirable vegetation depending on the sediment's seed bank. Suggest seeding with desirable species if possible.

Future Studies

It is apparent from the monitoring effort that not all the answers are known and additional study is needed. Based on the results of our monitoring activities, the following study needs were identified:

- elevation of the site in relation to the river
- depth of fine material and effects on soil moisture, fertility, and erosion
- species and rate at which to plant
- soil fertility
- proportion of coarse vs. fine material
- long-term management activities, such as burning and fertilization
- use of local or regional ecotypes
- use of native or non-native species

During the summer of 1999, the Corps of Engineers Natural Resource Project Office conducted field surveys of retired dredged material placement sites along the Mississippi River. Of the 86 sites identified in Pools 4 through 10, 46 sites were considered to be potential management sites on the basis of existing site conditions. These areas may be future sites for and sources of information on long-term establishment of vegetation on the Upper Mississippi River in the St. Paul District. (Randy Urich and Dan Oles, "Retired Dredged Material Site Inventory, Report of Findings and Recommendations." June 14, 2000, U.S. Army Corps of Engineers, St. Paul District, Natural Resource Project Office, 1114 South Oak Street, La Crescent, Minnesota 55947, 25 pp.)

In addition to the future study needs listed above, the project goals should be better defined, and more quantifiable measures of determining if the goals were achieved should be developed. This needs to be done in cooperation with participating agencies and interests. Additional study and site monitoring are needed to develop vegetation management plans and techniques for the long-term establishment of vegetation and achievement of vegetation goals on the Upper Mississippi River.

SUMMARY OF VEGETATION CHANGES ON DREDGED MATERIAL AND ENVIRONMENTAL MANAGEMENT PROGRAM SITES IN THE ST. PAUL DISTRICT, CORPS OF ENGINEERS

by

Robert Anfang, St. Paul District, Corps of Engineers
and
Gary Wege, Twin Cities Field Office, U. S. Fish and Wildlife Service

APPENDIX

SUMMARY OF VEGETATION CHANGES ON DREDGED MATERIAL AND ENVIRONMENTAL MANAGEMENT PROGRAM SITES IN THE ST. PAUL DISTRICT, CORPS OF ENGINEERS

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Robert Anfang, St. Paul District, Corps of Engineers
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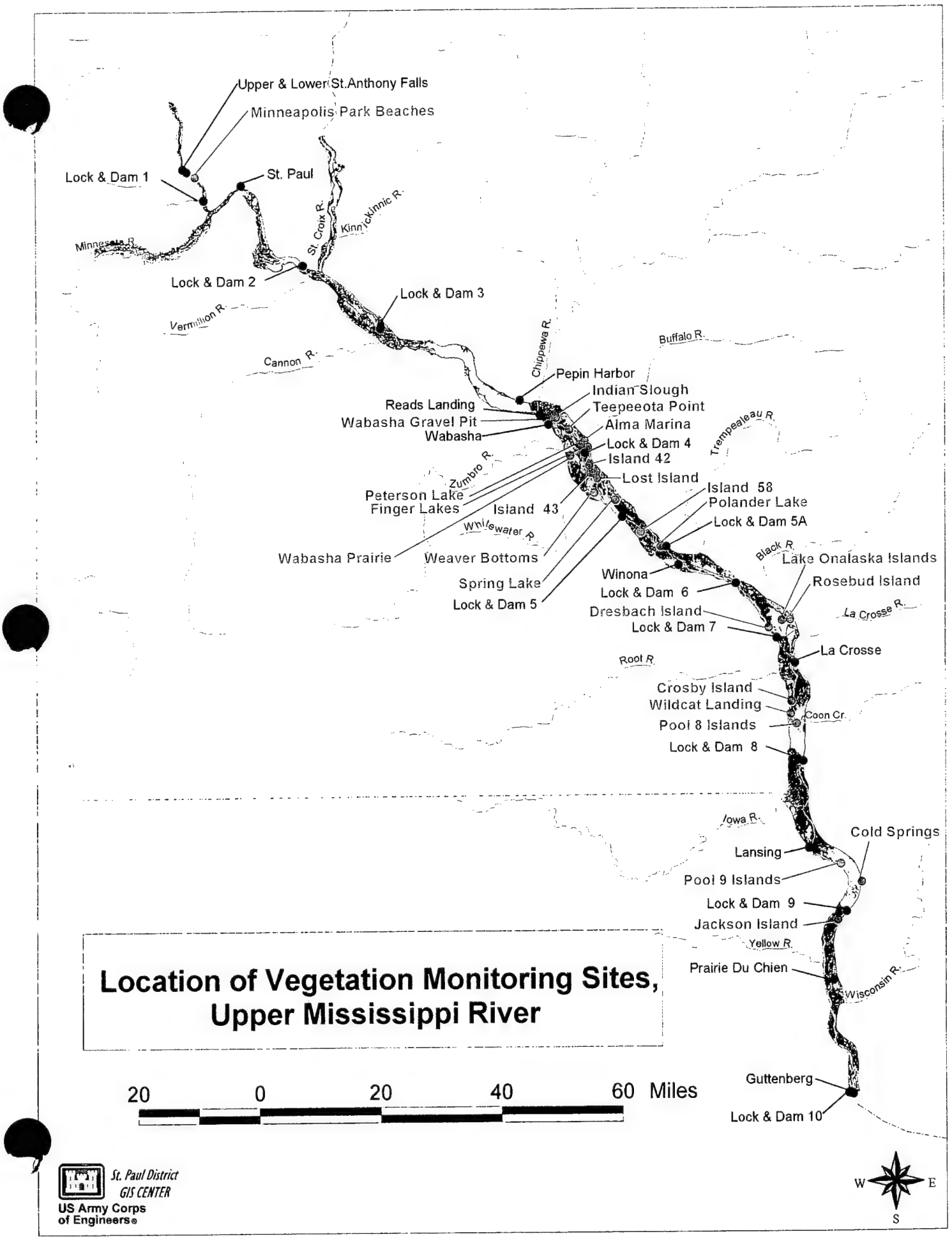
APPENDIX

TABLE OF CONTENTS

LOCATION MAP FOR VEGETATION STUDY SITES



Appendix. Location of vegetation monitoring sites, Upper Mississippi River.

SUMMARY LIST OF VEGETATION STUDY SITES

SUMMARY LIST OF VEGETATION SITES

In order by river mile from upstream to downstream

SITE NAME	RIVER MILE	DATE	SUMMARY OF VEGETATION PRACTICES
MINNEAPOLIS PARK BEACHES 1 and 2	851.5	11/86	Seeded and hay mulch. Species seeded included sand dropseed, switchgrass, blue grama, side oats grama, little bluestem, crown vetch, perennial ryegrass, Kentucky bluegrass. Mulched at 2 tons per acre.
	849.5	11/86	Seeded and hay mulch. Species seeded included sand dropseed, switchgrass, blue grama, side oats grama, little bluestem, crown vetch, perennial ryegrass, Kentucky bluegrass. Mulched at 2 tons per acre.
WABASHA GRAVEL PIT	760.0	9/85	Temporary ground cover established. Broadcast seeded with switchgrass, yellow sweet clover, alsike clover, and annual or perennial rye. No mulch. Spring-tooth harrow used on site.
INDIAN SLOUGH	759.0	MAY 1994	Big bluestem, little bluestem, Indian grass, switchgrass, side oats grama, prairie dropseed, rye, and four of the following: black-eyed Susan, yellow coneflower, rough blazing star, prairie clovers, leadplant, or stiff tickseed. Grasses seeded at 14 lb./ac.; rye at 20 lb./ac.; forbs at 15 oz./ac. Mulch 1/2 ton/ac. Wildflowers planted in April 1998. Oak root production method trees planted.
TEEPEEOTA POINT	757.3	8-9/84	Backwater dredged material (silt and clay) placed on top of sand by irrigation sprayer. Not seeded.
PETERSON LAKE	756	JUNE 1996	Big bluestem, little bluestem, Indian grass, switchgrass, side oats grama, sand dropseed drill seeded. Perennial rye nurse crop. Wildflowers planted at later dates.
ALMA MARINA	754.0	1984 to 85	Sand and fine material placed in 1984. In 1985 city graded and placed 8 inches of clay on top. Drill seeded rye, fescue, and bluegrass in fall 1985 at 80 lbs./acre.
FINGER LAKES	752.0	JUNE 1994	Switchgrass, side oats grama, Canada wild rye, sand dropseed, little bluestem, red clover at 22 lb./ac. Oats at 20 lb./ac. Mulch at 1 1/2 tons/ac. Other grasses and wildflowers planted at later dates.
	752.0	April 1992	Area downstream of dike seeded with switchgrass, side oats grama, Canada wild rye, sand dropseed, little bluestem, red clover, and oats.
	752.0	April 1998	Wildflowers planted.
WABASHA PRAIRIE	751.5	April 1999	Dredge spoil placed on 29-acre site and covered with 4 to 5 inches of organic soil. Seeded with 225 pounds of native grasses and a variety of wildflowers.
ISLAND 42	749.0	JUNE 1987	Seeded, raked, but not mulched. About 100 lbs./ac. Rye, bluegrass, brome, timothy, sand dropseed, and birds-foot trefoil.
ISLAND 43	746.5	MAY 1990	Planted willow cuttings along shore. Minnesota and Wisconsin DNR. Shoreline erosion protection.

LOST ISLAND	745.0	5/82	Seeded and hydromulched side slope of dredged material placement site. Small seeded area of annual rye. Species seeded included red clover, yellow sweetclover, switchgrass, sand dropseed, and annual rye.
	745.0	5/15/85	Second seeding of small portion of area in 1982. Species seeded were blazer perennial ryegrass, switchgrass, side oats grama, little bluestem, big bluestem, Canada wild rye, and crown vetch.
WEAVER BOTTOMS (Islands and closures)	745.0	Swan Island & MN12 June 1988 MN11 and 13 and WI10 B and C July 1988	Backwater dredge material placed on sand. Seeded and mulched. Swan Island seeded with Indian grass, switchgrass, bluestem, and Canada wild rye. Mallard Island not seeded. MN11 seeded with cordgrass, switchgrass, bluestem, and grama. MN12 seeded with dropseed and beachgrass sprigs planted. MN13 seeded with wheatgrass, needlegrass, and Canada wild rye and rice cutgrass sprigs planted. MN10 not seeded. WI 10B and C seeded with bluestem, Indian grass, and rye. Raked but not mulched.
	745.0	SWAN ISLAND 4/16/1991	Willow cuttings placed on shore of Swan Island at 4 locations. Native willow, hybrid willow, false indigo, and dogwood planted. Rock groins constructed.
	745.0	MALLARD ISLAND 6/1992	Aquatic plants and shore protection placed by Waterways Experiment Station. Rock groins constructed.
SPRING LAKE	743	JUNE 1995	Canada wild rye, prairie cordgrass, side oats grama, switchgrass, prairie clovers seeded at 15 lb.3oz./ac. Perennial rye at 10 lb./ac.
ISLAND 58	735.0	6/85	Fine sediment dredged from lock and placed on sediment. Not seeded.
	735	1999	Fine material placed on old disposal site and trees planted. 1-2 foot rooted stock. Swamp white oak, green ash, silver maple, and hackberry. Some with tree shelters and mats.
POLANDER	729	OCT. 1994	Big bluestem, side oats grama, Indian grass, sand dropseed, prairie clovers drill seeded. Perennial rye nurse crop. Wildflowers planted April 1998. Area prescribed burned. Trees planted.
LAKE ONALASKA ISLANDS	705.0	JUNE 1990	Broadcast seeded and mulched. Species included Canada wild rye, side oats grama, switchgrass, and perennial ryegrass. Other species planted by other agencies. Mulched.
	705.0	MAY 1991	Willow cuttings planted on shore of Broken Gun Island using water jet by Fish and Wildlife Service.
	705.0	FALL 1994 JUNE 1995	East half of Broken and west half of Cormorant Island burned. Seeded with red clover and alfalfa and fertilized.
ROSEBUD ISLAND	705.0	JUNE 1990	Area was broadcast seeded and fertilized. Channel cut seeded with brome, switchgrass, and rye and 25 lb./ac. Disposal site seeded with brome, switchgrass, crown vetch, sand dropseed, and rye at 31 lb./ac. Nurse crop of annual rye at 2 bushels/acre.
DRESBACH	704.5	10/78	Sediment placed on test plots to determine survival of trees.
	704.5	1985 ?	Small sand plots seeded.

CROSBY ISLAND	690.5	5/28/74	Planted beachgrass sprigs. University of Wisconsin.
	690.5	5/14/85	Seeded side slope of dredged material placement site and dragged fence over area. Species seeded were blazer perennial ryegrass, switchgrass, side oats grama, little bluestem, big bluestem, Canada wild rye, and crown vetch. No fine material. No mulch.
	690.5	4/30/86	Transplanted beachgrass sprigs to slide slope of disposal site.
WILDCAT LANDING	688.0	5/22/81	Seven plots seeded and cultipacked. No mulch or fertilizer applied. Species seeded included switchgrass, prairie dropseed, big bluestem, little bluestem, Indian grass, and sand bluestem. Wisconsin DNR.
POOL 8 ISLANDS	687.5		
Phase 1	687.5	JUNE 1991	Horseshoe Island drill seeded and mulched. Species seeded were Canada wild rye, thickspike wheatgrass, side oats grama, switchgrass, and rye. Mulch at 1 ton/ac.
	687.5	JUNE 1993	Shoreline of Boomerang Island planted with willows. 2 rows 1 foot apart.
	687.5	JUNE 1993	Boomerang Island planted with Canada wild rye, thickspike wheatgrass, side oats grama, switchgrass, and rye. Mulch at 1 ton/ac.
Phase 2	687.5	JUNE - JULY 1999	Islands drill seeded with various combinations of alfalfa, brome, timothy, oats, switchgrass, side oats grama, Canada wild rye, bluestem, dropseed, Indian grass, and native wildflowers. Beachgrass sprigs planted on sand hills. Willow cuttings along shoreline. Trees planted on some islands.
POOL 9 ISLANDS	655.5	1995	Rock island constructed. Not seeded. Some fine material placed on rock islands.
COLD SPRINGS	653.0	JUNE 1994	Switchgrass, Canada wild rye, timothy, alsike clover, annual rye at 29 lb./ac. Mulch 1 1/2 tons/ac.
JACKSON ISLAND	644.5	5/30/84	Fine sediment dredged from lock and placed on sand. Area seeded with switchgrass, big bluestem, side oats grama, and Indian grass. No mulch.

FORMULAE USED IN THE VEGETATION ANALYSIS

FORMULAE FOR VEGETATION ANALYSIS

1. Frequency relates to the number of times a species occurs in a given number of repeatedly placed small plots or sample points. It is expressed as a fraction of the total, usually in percent.

Relative frequency is a measure of a species frequency in relation to the frequency of all species. It is usually expressed in percent.

$$\text{Frequency} = \frac{\text{Number of points of occurrence of the species}}{\text{Total points taken}} \times 100$$

$$\text{Relative frequency} = \frac{\text{Frequency of the species}}{\text{Sum of frequency of all species}} \times 100$$

2. Dominance relates to the percent cover of a species on a given number of plots or sample points. It is expressed as an average percent cover.

Relative dominance is a measure of the species percent cover in relation to the cover of all species. It is usually expressed in percent.

$$\text{Dominance} = \frac{\text{Total \% cover of the species}}{\text{Total points taken}}$$

$$\text{Relative dominance} = \frac{\text{Total \% cover of the species}}{\text{Total \% cover of all species}} \times 100$$

3. Importance value is an overall measure of a species' role in the area based on its frequency of occurrence and percent cover. Relative values of frequency and dominance are averaged to determine the importance value of a species. The importance value of a species reaches a maximum of 100 in stands consisting of only one species.

$$\text{Importance Value} = \frac{\text{Relative dominance} + \text{Relative frequency}}{2}$$

4. The Jaccard Index is a mathematical expression for the similarity of plant communities. It is based on the presence-absence relationship between the number of species common between the areas and the total number of species.

Jaccard's Index of Species Similarity

$$IS_J = \frac{\text{Number of species common to both areas}}{\text{Number of species found on both areas}} \times 100$$

DISCUSSION OF ROBEL POLE MEASUREMENTS

Robel Pole Measurements

The relationship between visual obstruction measurements taken with a height-density pole and the weight of grassland vegetation was reported by Robel (1970) in the Journal of Range Management, 23(4):295-297. Visual obstruction measurements taken from a height of one meter and a distance of four meters also provide a reliable measure of the height and density of residual vegetation. Such measurements were used by Stanley C. Kohn to evaluate sharp-tailed grouse habitat in North Dakota during 1973 (unpublished P-R Report B-220, North Dakota Game and Fish Department), by Sam Mattise to evaluate various grazing systems' effects on sharp-tailed grouse habitats in western North Dakota (N.D. Outdoors 40(7):4), and by Leslie Rice and Arthur Carter in South Dakota in evaluating sharp-tailed grouse and prairie chicken habitat (Progress Report, Project W-75-R-16 & 17, South Dakota Department of Game, Fish, and Parks). Results of work on the Woodworth Study Area show that a strong relationship exists between the height-density of residual grassland vegetation obtained by the Robel method and wildlife reproductive activity and use of the vegetation.

At each plot location, 4 Robel readings are obtained. The average reading is then calculated for all of the plots. Each height-density measurement is taken at a mark on the pole where vegetation begins to hide the pole 100 percent and no other part of the pole can be seen below this mark. Measurements are rounded to the nearest half decimeter.

For HREP projects, a Robel reading of 1.5 decimeters after two years has been identified as a goal.

ALPHABETICAL LIST OF COMMON AND SCIENTIFIC NAMES OF PLANTS

COMMON AND SCIENTIFIC NAMES OF PLANTS

	Common Name	Scientific Name
	alfalfa	*Medicago sativa*
*	alsike clover	*Trifolium hybridum*
*	American beachgrass	*Ammophila breviligulata*
*	annual rye	*Secale cereale*
	aster	*Aster sp.*
	barnyard grass	*Echinochloa crusgalli*
	beggarticks	*Bidens frondosa*
	bentgrass	*Agrostis sp.*
*	big bluestem	*Andropogon gerardii*
	bindweed	*Convolvulus arvensis*
*	birds-foot trefoil	*Lotus corniculatus*
	black locust	*Robinia pseudo-acacia*
*	black-eyed Susan	*Rudbeckia hirta*
*	blue grama	*Bouteloua gracilis*
	blue vervain	*Verbena hastata*
	bluegrass	*Poa sp.*
	boneset	*Eupatorium perfoliatum*
	brome	*Bromus sp.*
	bulrush	*Scirpus sp.*
*	bush clover	*Lespedeza capitata*
	butter and eggs	*Linaria vulgaris*
*	butterfly weed	*Asclepias tuberosa*
*	button blazing star	*Liatris sp.*
*	buttonbush	*Cephalanthus occidentalis*
	Canada bluejoint grass	*Calamagrostis canadensis*
*	Canada wild rye	*Elymus canadensis*
	carpetweed	*Mollugo verticillata*
	chickweed	*Cerastium sp.*
	cinquefoil	*Potentilla sp.*
	clammyweed	*Polanisia graveolens*
	clearweed	*Pilea pumila*
	clover	*Melilotus sp.*
	cocklebur	*Xanthium sp.*
*	compass-plant	*Silpbium laciniatum*
	cottonwood	*Populus sp.*
	crabgrass	*Digitaria sanguinalis*
*	crown vetch	*Coronilla varia*
*	crown vetch	*Vicia angustafolium*
	cutleaf water horehound	*Lycopus americanus*
	daisy fleabane	*Erigeron annuus*
	dandelion	*Taraxacum officinale*
	dock	*Rumex crispus*
	dogbane	*Apocynum sp.*
*	dogwood	*Cornus sp.*
*	early sunflower	*Helianthus sp.*
	evening primrose	*Oenothera biennis*
*	false indigo	*Amorpha fruticosa*
	fescue	*Festuca sp.*
	flower-of-an-hour	*Hibiscus trionum*
*	foxtail	*Setaria viridis*
	foxtail barely	*Hordeum jubatum*

	goat's beard	*Tragopogon pratensis*
	goldenrod	*Solidago sp.*
*	grape	*Vitis sp.*
*	green needlegrass	*Stipa viridula*
	hairy lettuce	*Lactuca sp.*
	hoary alyssum	*Berterroa incana*
*	hoary vervain	*Verbena stricta*
	hop clover	*Trifolium procumbens*
	horsemint	*Monarda punctata*
	horsetail	*Equisetum sp.*
*	Indian grass	*Sorghastrum nutans*
	jointweed	*Polygonella articulata*
*	Kentucky bluegrass	*Poa pratensis*
	lambsquarters	*Chenopodium album*
*	leadplant	*Amorpha canescens*
*	little bluestem	*Andropogon scoparius*
	lovegrass	*Eragrostis sp.*
	marestail	*Erigeron canadensis*
*	Maximilian sunflower	*Helianthus maximiliani*
	milk purslane	*Euphorbia supina*
	milkweed	*Asclepias sp.*
	moonseed	*Manispermum canadense*
	Muhlenbergia	*Muhlenbergia sp.*
	mullein	*Verbascum thapsus*
	mustard	*Brassica sp.*
	mustard	*Cruciferae*
	nightshade	*Solanum nigrum*
*	oats	*Avena sativa*
*	Ohio spiderwort	*Tradecantia ohiensis*
*	oldfield goldenrod	*Solidago sp.*
*	panicled (gray) dogwood	*Cornus paniculata*
*	partridge pea	*Chamaecrista fasciculate*
	paspalum	*Paspalum ciliatifolium*
	pearly everlasting	*Anaphalis margaritacea*
	pennycress	*Thlaspi arvense*
	peppergrass	*Lipidium densiflorum*
*	perennial rye	*Lolium perenne*
	pigweed	*Amaranthus sp.*
	plantain	*Plantago sp.*
	poison ivy	*Rhus radicans*
*	prairie blazing star	*Liatris pycnostachya*
*	prairie clover	*Petalostemum sp.*
*	prairie cordgrass	*Spartina pectinata*
*	prairie dropseed	*Sporobolus heterolopis*
*	prairie onion	*Allium stellatum*
*	purple coneflower	*Ratibida columnifera*
	purple loosestrife	*Lythrum salicaria*
	purple sandgrass	*Triplasis purpurea*
	quackgrass	*Agropyron repens*
	queen Anne's lace	*Daucus carota*
	ragweed	*Ambrosia sp.*
*	rattlesnake master	*Eryngium aqualicum*
*	red clover	*Trifolium pratense*
	reed canary grass	*Phalaris arundinacea*
	reed grass	*Phragmites communis*
	reed meadow grass	*Glyceria grandis*

*	rice cutgrass	*Leersia oryzoides*
*	rough blazing star	*Liatris aspera*
	rough pigweed	*Amaranthus retroflexus*
*	roundheaded bushclover	*Lespedeza sp.*
	Russian thistle	*Salsola pestifer*
*	sand bluestem	*Andropogon halli*
*	sand cherry	*Prunus pumila*
*	sand dropseed	*Sporobolus cryptandrus*
*	sand reedgrass	*Calamovilfa longifolia*
	sandbur	*Cenchrus longispinus*
	sedge	*Carex sp.*
	shepherd's purse	*Capsella bursa-pastoris*
*	showy sunflower	*Helianthus laetiflorus*
*	side oats grama	*Bouteloua curtipendula*
	smartweed	*Polygonum sp.*
*	smooth brome	*Bromis inermis*
	sneezeweed	*Helenium autumnale*
	sorrel	*Rumes sp.*
	spiderwort	*Tradecantia virginiana*
	spike rush	*Eleocharis sp.*
*	stiff tickseed	*Coreopsis palmata*
	sumac	*Rhus sp.*
	sunflower	*Helianthus sp.*
	sweetclover	*Melilotus sp.*
*	switchgrass	*Panicum virgatum*
*	thickspike wheatgrass	*Agropyron dasystachyum*
	thistle	*Cirsium sp.*
*	timothy	*Phleum pratense*
	touch-me-not	*Impatiens biflora*
	umbrella sedge	*Cyperus schweinitzii*
	velvet leaf	*Abutilon theophrasti*
	Virginia creeper	*Parthenocissus vitacea*
	Virginia wild rye	*Elymus virginicus*
	water horehound	*Lycopus sp.*
	wedgegrass	*Sphenopholis intermedia*
*	western sunflower	*Helianthus occidentalis*
	wheatgrass	*Agropyron sp.*
	white champion	*Lychnis alba*
*	white prairie clover	*Petalostemum candidum*
	white sweetclover	*Melilotus alba*
	wild mint	*Mentha arvensis*
	wild oats	*Danthonia intermedia*
*	willow	*Salix sp.*
	winged pigweed	*Cycloloma atriplicifolium*
	witchgrass	*Panicum capillare*
	wormwood	*Artemisia biennis*
*	yellow coneflower	*Ratibida pinnata*
	yellow nut sedge	*Cyperus sp.*
*	yellow sweetclover	*Melilotus officinalis*
	yellow wood sorrel	*Oxalis stricta*

NOTE: * denotes seeded or planted species

SOIL ANALYSIS OF SELECTED VEGETATION STUDY SITES

RESULTS OF SOIL ANALYSIS

In 1994 soil samples were taken to determine the amount of fine material present. The samples were primarily taken using a soil probe, which samples approximately the surface 8 to 12 inches. The percentages show the amount of material passing the indicated sieve.

Sample Location	Dry Weight of Sample (grams)	Percent Passing Sieve		Soil Type
		#4	#200	
Cold Springs				
dense cover	289	97.3	66.2	sandy lean clay with trace of gravel (CL)
sparse cover	320	98.3	68.1	sandy lean clay with trace of gravel (CL/CL-ML)
no cover (depression)	505	99.1	58.3	sandy lean clay (CL)
dense cover	324	99.4	71.4	lean clay with sand (CL)
Pool 8 Islands				
Horseshoe Island				
dense cover	284	98.8	42.4	clayey sand with trace of gravel (SC)
Boomerang Island				
sparse cover	477	99.9	29.1	clayey sand (SC)
dense cover	334	99.8	43.9	clayey sand (SC/SC-SM)
Onalaska Islands				
Broken Gun				
dense cover	276	100.0	37.0	clayey sand (SC)
Cormorant				
dense cover	323	97.9	37.7	clayey sand with trace of gravel (SC)
Arrowhead				
dense cover	259	99.9	51.4	sandy lean clay (CL/SC)
Island 42				
dense cover	392	99.8	13.5	silty sand (SM/SP-SM)
Weaver Bottoms				
Swan Island				
dense cover	332	99.5	27.2	clayey sand (SC)
Mallard Island				
sparse cover	449	99.7	32.2	clayey sand (SC)